FISHERY DATA SERIES NO. 93

STOCK ORIGINS OF COHO SALMON IN THE COMMERCIAL HARVESTS FROM UPPER COOK INLET, ALASKA[1]

By

Douglas Vincent-Lang
and
Douglas McBride

Alaska Department of Fish and Game
Division of Sport Fish
Juneau, Alaska 99802

April 1989

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-4, Job No. S-32-12

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF FIGURES (Continued)

LIST OF APPENDIX TABLES

LIST OF APPENDIX TABLES (Continued)

LIST OF APPENDIX TABLES (Continued)

ABSTRACT

The stock structures of the mixed-stock harvests of coho salmon *Oncorhynchus kisutch* in the commercial fisheries of Upper Cook Inlet, Alaska, during 1988 were examined using timing, length-at-age, and scale pattern information. Based on timing and length-at-age information, a majority of the coho salmon harvested in the Central District drift net and Northern District west-side set net fisheries appear to originate from Northern District drainages, in particular the Susitna River. This same information indicates that a majority of the coho salmon harvested in the Central District west-side and east-side set net fisheries appear to originate from Kenai Peninsula drainages, in particular the Kenai River. These same data indicate, however, that the gear used to harvest coho salmon in the commercial fisheries is selective towards smaller sized coho salmon. Given this, it is not possible to distinguish whether the observed differences in length-at-age between drainages are the result of genetic stock differences or differences due to gear selectivity. A limited analysis of freshwater and marine scale patterns of Susitna and Kenai River coho salmon stocks indicate that marine scale pattern variables cannot be used to distinguish between the stock structures of mixed stock harvests of coho salmon in the commercial fisheries. Further analyses of freshwater scale variables that may not be correlated to fish length will need to be investigated.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, Upper Cook Inlet, stock origins, commercial fishery, age, sex, length, scale patterns, length-at-age, Kenai River, Susitna River, Swanson River, Little Susitna River.

INTRODUCTION

Tributaries to upper Cook Inlet (Figure 1) support the largest sport fisheries for sea-run coho salmon *Oncorhynchus kisutch* in Alaska (Mills 1988). During the years 1977 through 1987, about 50% of the sea-run coho salmon harvested by sport anglers statewide were from upper Cook Inlet tributaries (Table 1). The largest fisheries occur in tributaries on the Kenai River, notably the Kenai, Swanson, Anchor, and Ninilchik Rivers, and Deep Creek. An estimated 76,106 coho salmon were harvested by sport anglers fishing Kenai Peninsula waters during 1987 (Table 2). Extensive fisheries also occur on various tributaries throughout the Susitna River, chiefly on the Deshka River and Lake and Alexander Creeks. Notable fisheries also occur in western upper Cook Inlet, notably on the Kustatan, Chuit, and Theodore Rivers. Anglers fishing Susitna River and western upper Cook Inlet tributaries during 1987 harvested an estimated 29,000 coho salmon. Extensive fisheries also occur on the Little Susitna River and other waters flowing into northern upper Cook Inlet. Anglers fishing these waters harvested an estimated 28,700 coho salmon during 1987.

Mixed-stocks of coho salmon are also harvested in various commercial fisheries in upper Cook Inlet (Figure 2). During the years 1977 through 1987, an average of just over 450,000 coho salmon have been harvested in the various drift and set net fisheries that occur in upper Cook Inlet (Table 3). The drift net fishery that occurs in the Central District is the largest of the commercial fisheries. This fishery harvested just over 200,000 coho salmon, or about 45% of the total upper Cook Inlet harvest of just over 450,000 coho salmon during 1987 (Table 4). Extensive harvests also occur in the various set net fisheries in the Central and Northern Districts of upper Cook Inlet. In total, these set net fisheries harvested nearly 250,000 coho salmon during 1987 with the Central District east-side and Northern District west-side set net fisheries being the largest (Table 4).

To date, only limited analyses have been conducted to estimate the stock-specific origins of the coho salmon harvests in the mixed-stock commercial fisheries. The little work that has been completed suggests that it may be possible to estimate the stock-specific origins of these harvests using a combination of migratory timing, size-at-age, and scale pattern statistics. This work is based on limited analysis of tagging/recovery of migrating adult coho salmon in upper Cook Inlet commercial fisheries (Tarbox 1988) and length-at-age (Wadman 1971) and scale patterns (Bethe 1977, Robertson 1979) of mixed and specific stocks of upper Cook Inlet coho salmon.

The inability to estimate the stock-specific harvests of coho salmon in the mixed-stock marine fisheries is a serious problem for managers of the inriver sport fisheries of upper Cook Inlet. Inriver production and optimum escapement goals cannot be defined because of the unknown quantity of each stock that is removed by the mixed-stock marine commercial fisheries. The unquantifiable stock-specific harvests also make it difficult to evaluate temporal run strength which is needed for inseason management.

For these reasons, a study was initiated in 1987 to evaluate the stock-specific origins of coho salmon in the mixed-stock commercial fisheries of

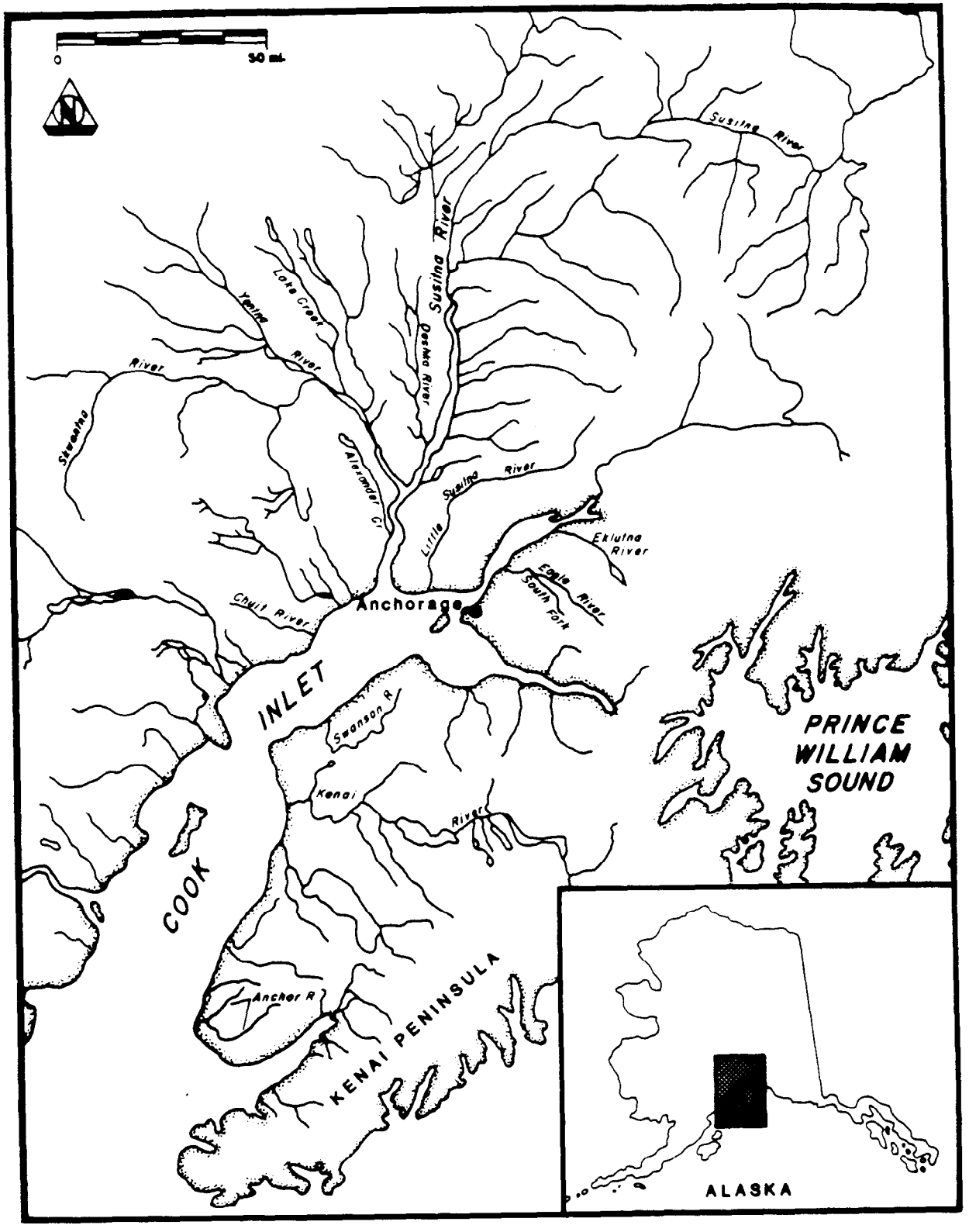

Figure 1. Major tributaries in upper Cook Inlet that support sport fisheries for coho salmon.

Table 1. Sport harvests of coho salmon in upper Cook Inlet as a comparison of the statewide sport harvests for the years 1977 through 1987 (Mills 1988).

Year	Statewide Harvest	Upper Cook Inlet Harvest	Percent of Statewide Harvest
1977	104,991	51,907	49.4
1978	131,945	65,230	49.5
1979	119,329	65,175	54.6
1980	164,302	96,032	58.4
1981	125,666	72,835	58.0
1982	195,550	106,581	54.5
1983	149,270	63,994	42.9
1984	238,536	134,008	56.2
1985	200,773	107,008	53.6
1986	255,887	136,231	53.2
1987	235,435	133,818	56.8
Mean	174,699	93,945	53.8

Table 2. Sport harvests of sea-run coho salmon in various areas of upper Cook Inlet during 1987 (Mills 1988).

Area	Harvest	Percent of UCI Harvest	Percent of Statewide Harvest
Kenai Peninsula	76,106	56.9	32.2
Susitna River/ Western Cook Inlet	29,010	21.7	12.3
Little Susitna River/ Northern Cook Inlet	28,702	21.4	12.2
Total: Upper Cook Inlet	133,818	100.0	56.8
Statewide	235,435		

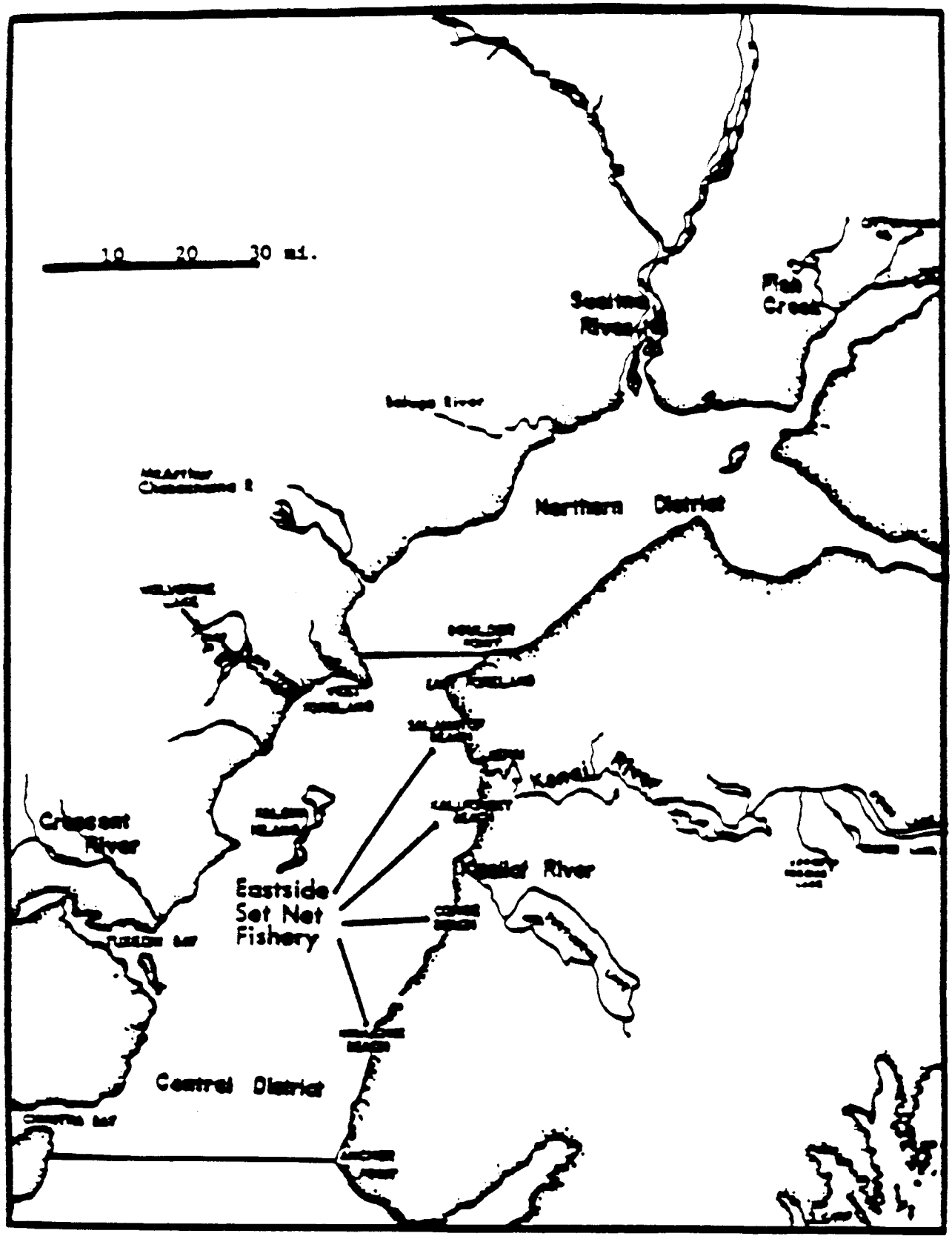

Figure 2. Major commercial fisheries in upper Cook Inlet, Alaska.

Table 3. Harvests of coho salmon in the upper Cook Inlet commercial fisheries for the years 1977 through 1987.

Year	Harvest
1977	192,599
1978	219,360
1979	265,166
1980	261,600
1981	485,148
1982	793,937
1983	516,322
1984	442,619
1985	619,924
1986	739,292
1987	451,404
Mean	453,397

Table 4. Harvests of coho salmon in the various mixed-stock marine commercial fisheries of upper Cook Inlet during 1987.

District	Fishery	Harvest	Percent of Total
Central	Drift Net	202,577	44.9
	West-side Set Net	43,041	9.5
	East-side Set Net	74,977	16.6
	Kalgin Set Net	31,889	7.1
	Sub Total	352,484	78.1
Northern	East-side Set Net	34,838	7.7
	West-side Set Net	64,082	14.2
	Sub Total	98,920	21.9
TOTAL		451,404	100.0

upper Cook Inlet. Results of the 1987-1988 study were to standardize the collection and reading of coho salmon scales throughout upper Cook Inlet and collocate and evaluate historical data to gain a better understanding of how the commercial fishery in upper Cook Inlet operates with respect to coho salmon. Objectives of the 1988-1989 study were to:

1. Estimate (a) the immigrational timings and (b) the age, sex, and length compositions of coho salmon stocks of known origin in upper Cook Inlet tributaries.

2. Estimate (a) the timing and (b) the age, sex, and length compositions of coho salmon harvests of unknown origin in the upper Cook Inlet commercial fisheries.

3. Evaluate the feasibility of using migratory timing, length-at-age, and scale pattern statistics to identify and quantify the stock-specific origins of coho salmon harvested in the mixed-stock commercial fisheries of upper Cook Inlet.

METHODS

Biological Data

The age, sex, and length compositions of coho salmon stocks of known origin were summarized for major upper Cook Inlet tributaries. For purposes of data collection, upper Cook Inlet was divided into two areas: (1) Kenai Peninsula and (2) Northern District (Figure 1). Tributaries within each area sampled during 1988 are presented in Table 5. At each collection point, coho salmon were sampled for age, sex, and length information. A variety of sampling procedures were used to obtain fish for sampling including creel surveys, weirs, and fishwheels. Fish were measured for mid-eye to fork-of-tail length to the nearest 1/2 cm and sexed based on external characteristics. Three scales were also removed from the preferred area (Clutter and Whitesel 1956) and mounted on adhesive coated cards. Cards were later thermohydraulically pressed against plastic cards and the resulting scale impressions were displayed on a microfiche reader for age determination[1]. All scales were read by a single reader whose interpretation of scale patterns was standardized.

The age, sex, and length compositions of coho salmon harvests of unknown origin were summarized for major upper Cook Inlet commercial fisheries. For purposes of data collection, upper Cook Inlet was divided into two areas: (1) the Central District and (2) the Northern District (Figure 2). Fisheries within each area sampled during 1988 are presented in Table 6. Sampling was conducted using procedures described above.

[1] The numeral preceding the decimal represents the number of freshwater annuli whereas the numeral following the decimal represents the number of marine annuli (European method). Total age from brood is the sum of these two numerals plus one.

Table 5. Upper Cook Inlet tributaries sampled for immigrational timing and biological data of coho salmon during 1988.

Area	Tributary	Type of Collection	Number of Scales
Kenai Peninsula	Kenai River - Early Run	Creel	433
	Kenai River - Late Run	Creel	562
	Russian River	Weir	98
	Swanson River	Weir	819
	Anchor River	Creel/Weir	276
	Total		2,188
Northern	Susitna Drainage		
	Susitna Landing	Creel	261
	Talkeetna Landing	Creel	377
	Lake Creek	Creel	462
	Yentna River	Fishwheel	225
	Alexander Creek	Creel	24
	Sub Total		1,349
	Little Susitna River	Creel/Weir	694
	Eklutna River	Hatchery	182
	Misc. West-side Streams	Escapement	56
	Total		2,281
Upper Cook Inlet Total			4,469

Table 6. Upper Cook Inlet commercial fisheries sampled for timing and biological data of coho salmon during 1988.

District	Fishery	Number of Scales
Central	Drift Net	484
	East-side Set Net	202
	West-side Set Net	208
	Total	894
Northern	West-side Set Net	425
Total		1,319

The proportional age composition was estimated for each collection point. Letting p_i be the estimated proportion of age group i, the variance of p_i can be estimated (Scheaffer et al. 1979):

$$V(p_i) = p_i(1-p_i)/n_t \quad (1)$$

where n_t is the total number of coho salmon sampled at collection site t. Mean length at age by sex and its variance were estimated for each collection site using standard normal procedures.

Scale patterns in the freshwater and marine circuli were quantified for random sub-samples (n=50) of the scales collected in the Kenai River (early-run) and Susitna Landing (Susitna River) creel surveys. Scale impressions were projected at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Scale impressions were measured on a Talos digitizing tablet and recorded on a COMPAQ microcomputer. Distances were measured for the following scale growth zones: (1) scale focus to the outside edge of the last freshwater annulus (freshwater zone) and (2) the last freshwater circuli to the outside edge of the scale (marine zone). All measurements were made along an axes 17 1/2° dorsal from the anterior-posterior axis of the scales. These measurements were plotted against the mid-eye to fork-of-tail length of each fish. Correlation between the width of freshwater and marine zones to the length of fish was tested using a t-test (MINITAB 1988).

Timing Data

The entry timing of coho salmon stocks into the Northern District tributaries was estimated based on fishwheel counts at the Yentna River (approximately 51 km from saltwater), a tributary to the Susitna River, and weir counts on the Little Susitna River (approximately 55 km from saltwater). The entry timings of coho salmon stocks into the Kenai Peninsula tributaries was estimated based on catch-per-unit-effort (CPUE) statistics for Kenai River sport fishery (ranging from 5 to 50 km from saltwater) and weir counts for the Swanson River (approximately 2 km from saltwater). The timing of commercial harvests was estimated based on weekly harvests in each fishery. Harvest statistics were compiled by the ADF&G Division of Commercial Fisheries from sales receipts (fish tickets). Entry and harvest timings were estimated by plotting weekly timing data.

Harvest Apportionment

Quantitative descriptions of timings and length-at-age were investigated as to their feasibility for identifying and quantifying the stock-specific origins of coho salmon harvested in the mixed-stock commercial fisheries of upper Cook Inlet. Timing was used to determine stocks of known origin that could be available in the mixed-stock commercial fisheries. Duration of availability was determined based on migratory rate data for tagged coho salmon in upper Cook Inlet (Tarbox 1988). These data indicate that coho salmon could be available to a commercial fishery for a period up to 25 days.

Plots showing means of length-at-age with associated 95% confidence intervals for each sample of known origin were used to determine probable stock groupings. Based on a consideration of duration of availability and known biases in the data, samples of known origin (standards) were developed for each terminal location. The length-at-age data from the resulting standards were then evaluated as to their feasibility for identifying and quantifying the stock-specific origins of coho salmon harvested in the mixed-stock commercial fisheries of upper Cook Inlet.

RESULTS

1988 Commercial Fishery

During 1988, just over 8.5 million salmon were harvested by upper Cook Inlet commercial fisheries. This was the second largest harvest in the history of the upper Cook Inlet commercial fishery. The composition of the 1988 harvest was 79.4% sockeye salmon *Oncorhynchus nerka*, 8.3% chum salmon *O. keta*, 6.5% coho salmon, 5.5% pink salmon *O. gorbuscha*, and 0.3% chinook salmon *O. tshawytscha* (Figure 3). This compares with a historical harvest composition of 57.9% sockeye salmon, 31.4% pink salmon, 17.3% chum salmon, 8.3% coho salmon, and 0.4% chinook salmon. The historical mean harvest of the upper Cook Inlet commercial fishery is 4.1 million salmon.

The 1988 harvest of 560,000 coho salmon was the fourth largest on record. This compares with a historical mean harvest of 338,000 coho salmon (Figure 4). Most of the 1988 harvest occurred in the Central District drift net and Northern District west-side set net fisheries. These fisheries harvested just over 70% of the total upper Cook Inlet coho salmon harvest (Figure 5). Of these two fisheries, the Central District drift net fishery is the largest, comprising nearly 50% of the total 1988 upper Cook Inlet harvest of coho salmon. Other fisheries of significance during 1988 were the Central District east-side and west-side set net fisheries.

Based on historical data, there appears to be a positive relationship between the numbers of coho and sockeye salmon harvested in the upper Cook Inlet commercial fisheries (Figure 6). High interceptions of coho salmon can be expected during years of high sockeye salmon harvest. However, this relationship has not held for the years 1987 and 1988. During 1987 and 1988, the Central District drift net fishery was moved in and out of the central portion of upper Cook Inlet in an effort to reduce the incidental harvest of Northern District bound sockeye and coho salmon. The results of these efforts were dramatic. During 1988, relatively few coho salmon were harvested when the drift net fishery fished within a 3 mile corridor of the Central District east-side beaches than when the fishery occurred outside this corridor (Figure 7).

The timing of coho salmon harvests during 1988 differed by fishery (Figure 8). In order from earliest to late, harvests of coho salmon peaked in the Central District drift net, the Northern District west-side set net, the Central District east-side set net, and the Central District west-side set net fisheries. The species compositions of the harvest within each

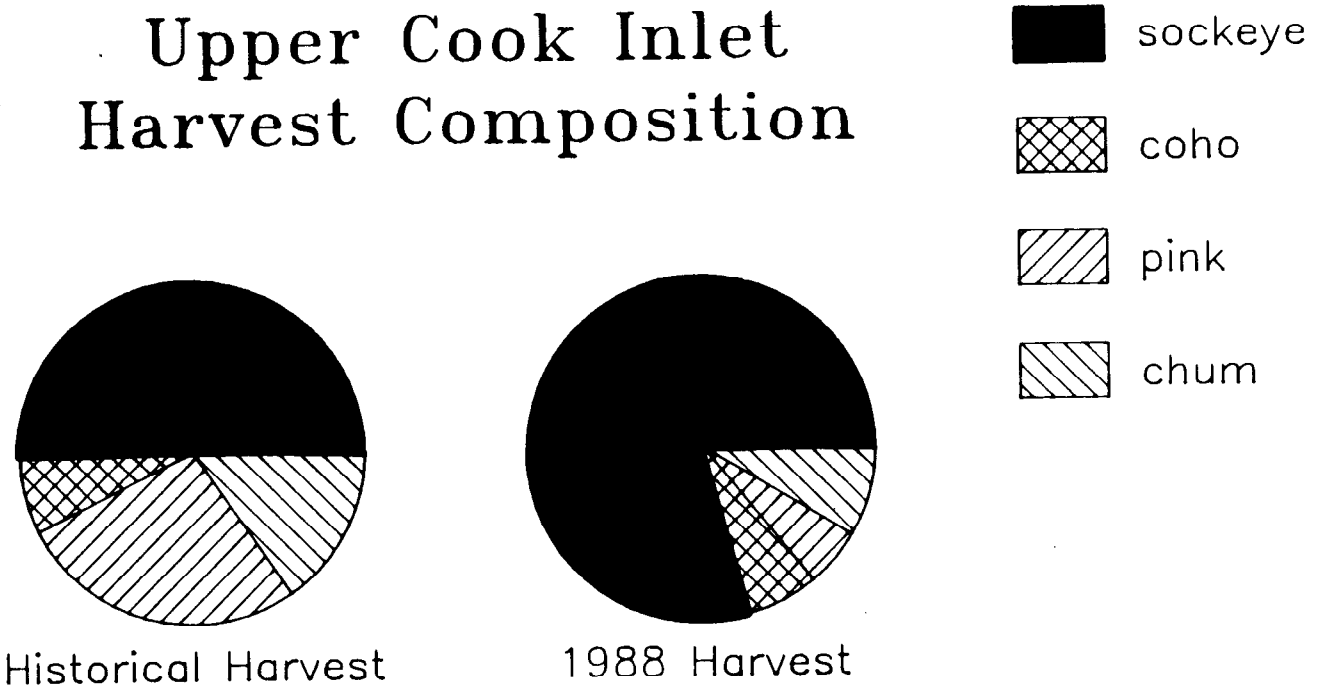

Figure 3. Species composition of the 1988 upper Cook Inlet commercial harvest in comparison to the historical species composition.

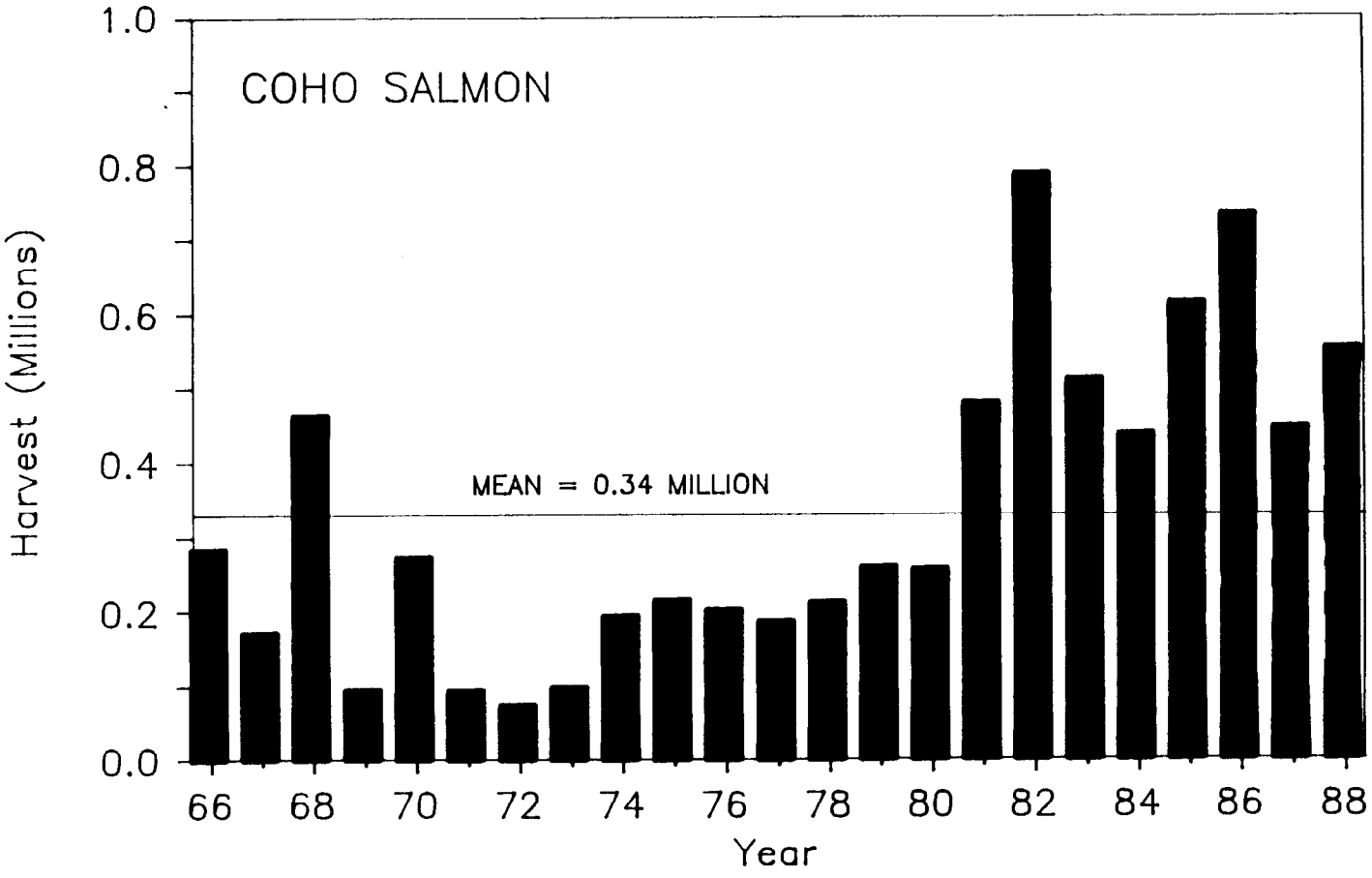

Figure 4. Historical harvests of coho salmon in the upper Cook Inlet commercial fisheries, 1966 - 1988.

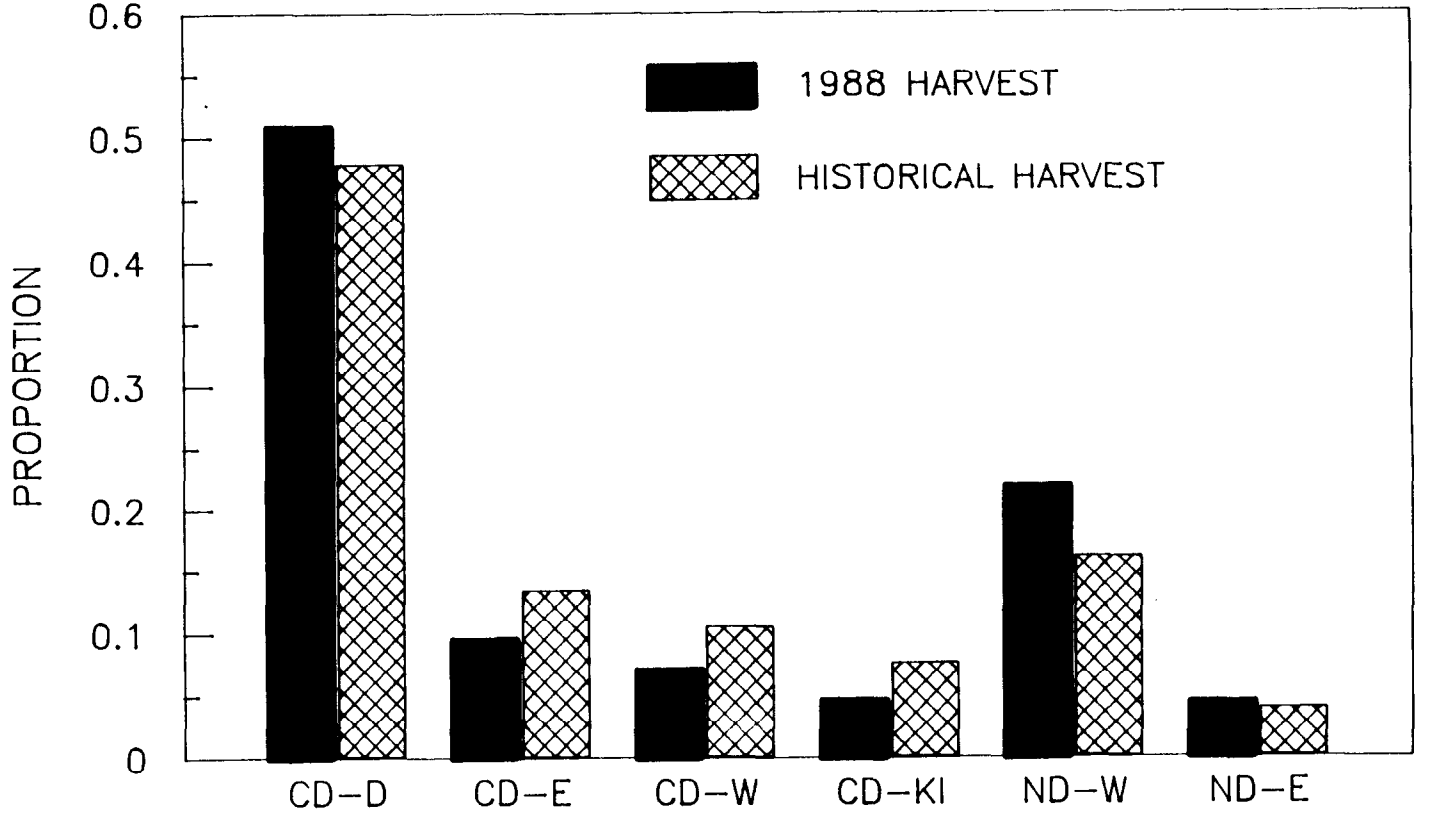

Figure 5. Proportional harvest, by fishery, of coho salmon in the various commercial fisheries of upper Cook Inlet during 1988 in comparison to the historical proportional harvest, by fishery.

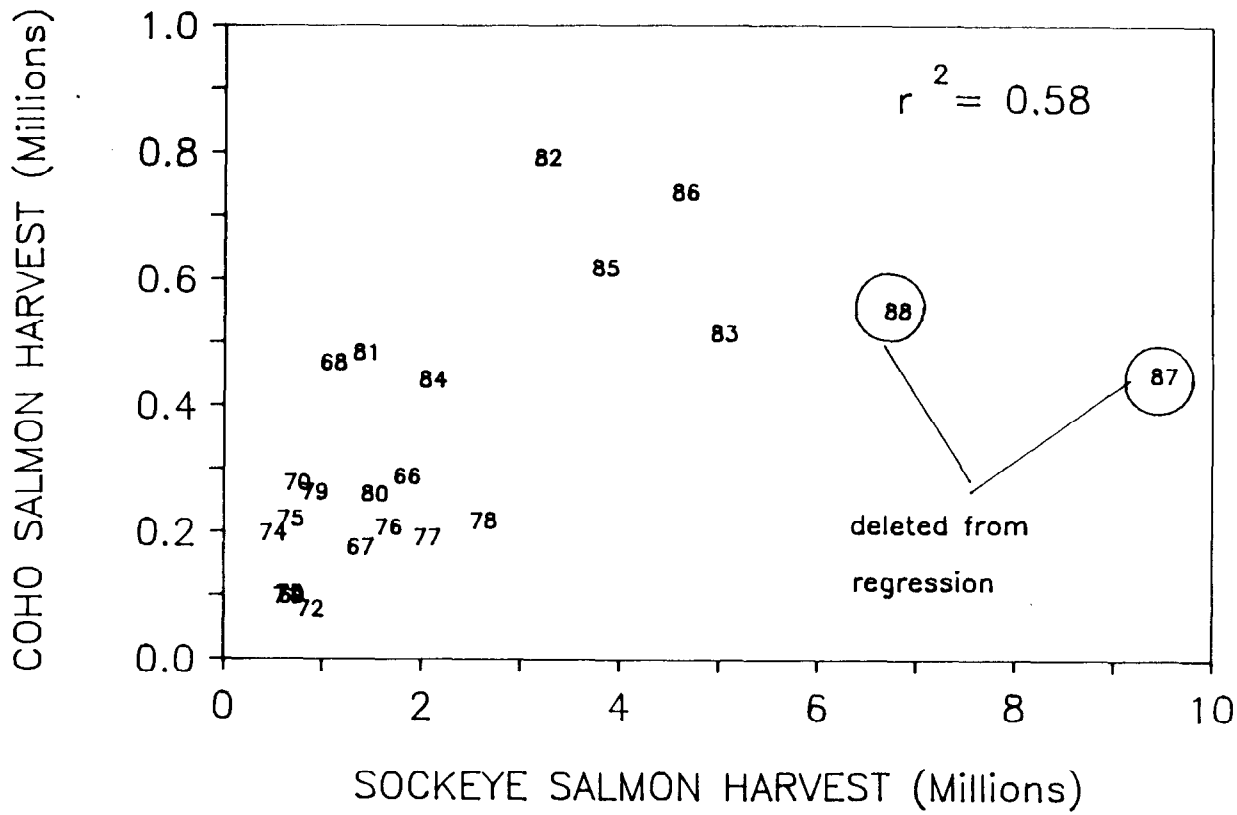

Figure 6. Relationship between number of coho and sockeye salmon harvested in the upper Cook Inlet commercial fisheries during the years 1966 - 1988.

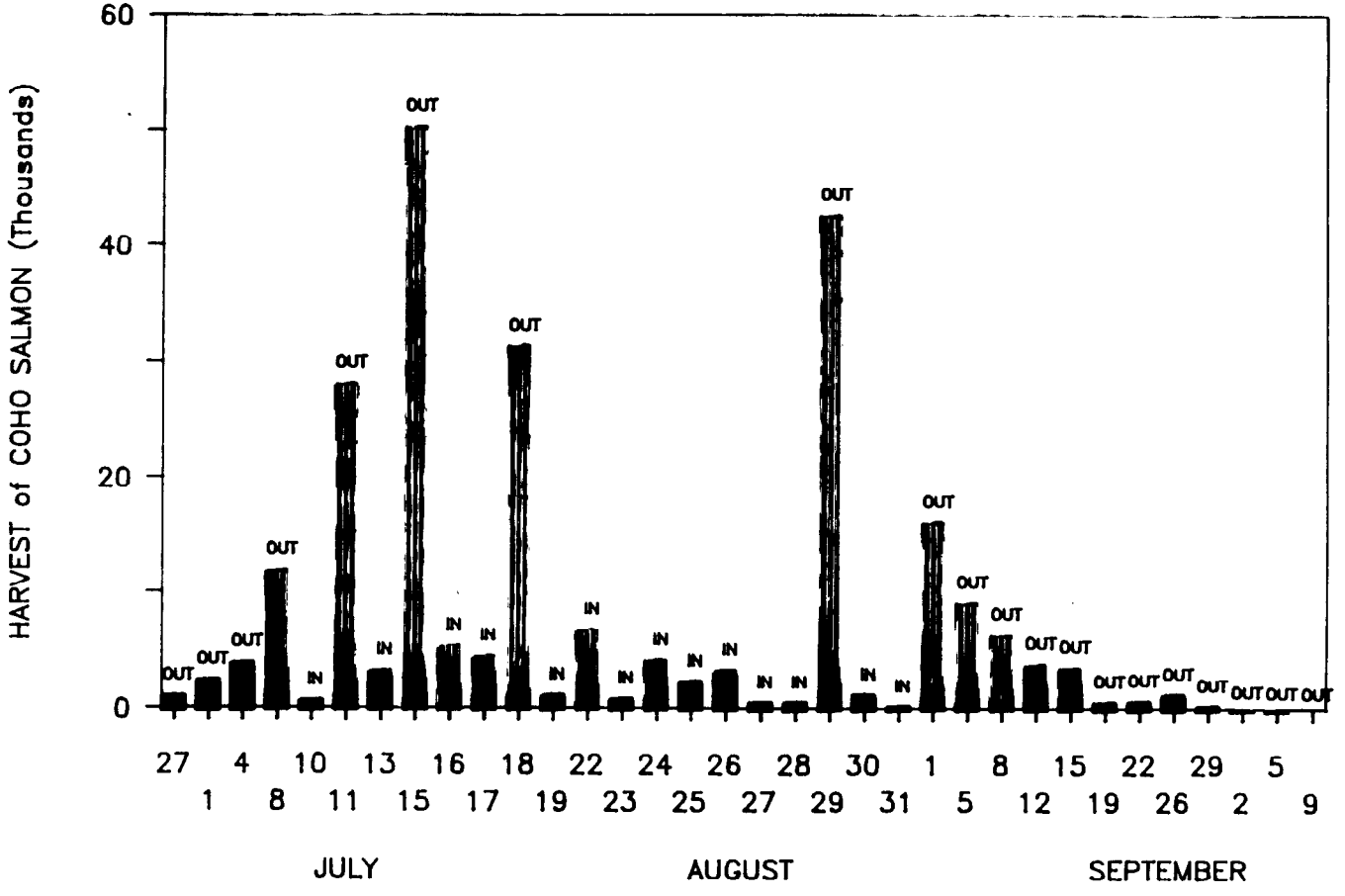

Figure 7. Harvests of coho salmon in the Central District drift net fishery during 1988 as a function of fleet location.

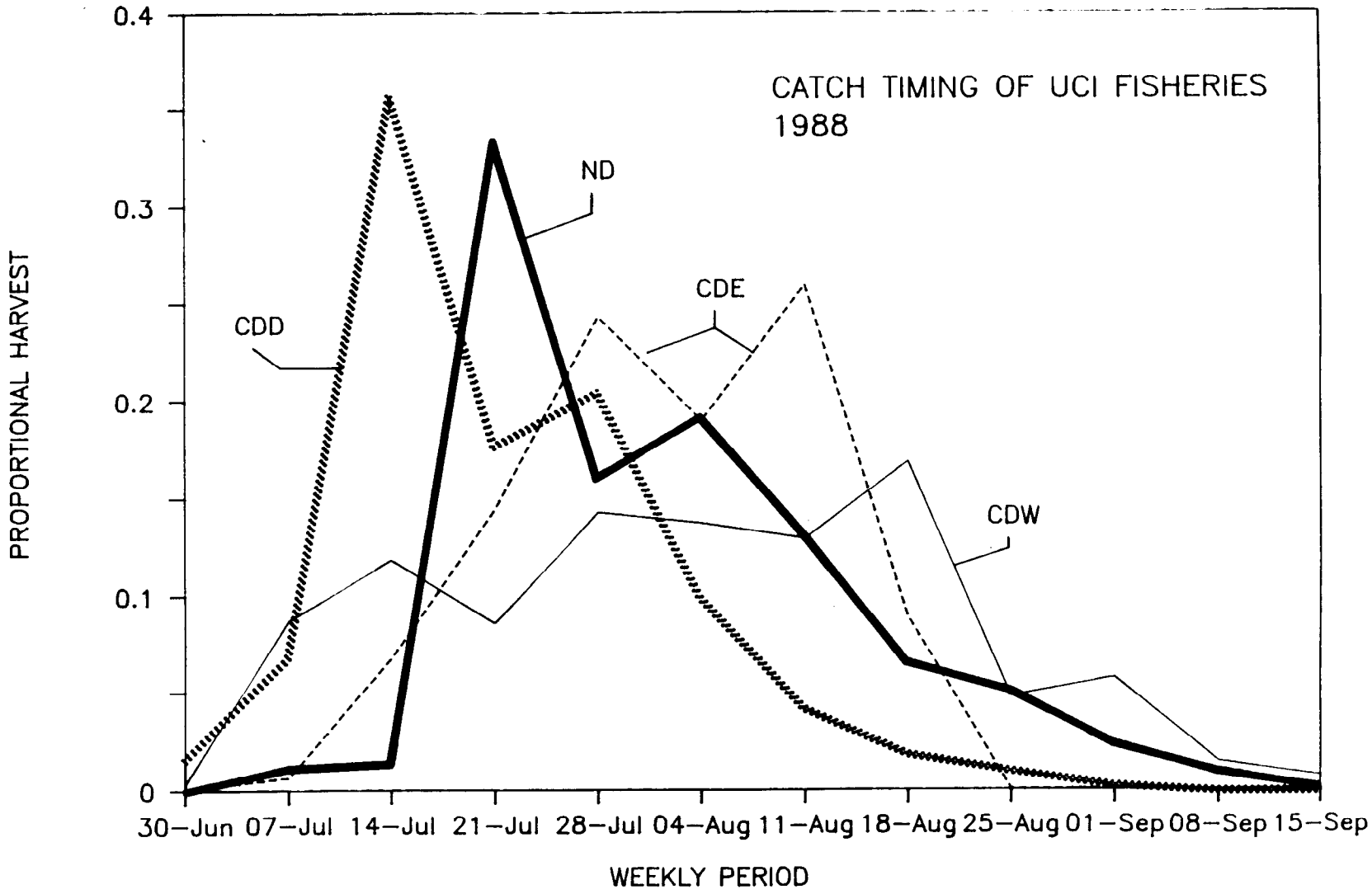

Figure 8. Proportional timing of harvests, by week, in the Central District drift net (CDD), Northern District west-side set net (ND), and Central District east-side (CDE) and west-side (CDW) set net fisheries during 1988.

fishery also changed over time. For example, in the Northern District west-side set net fishery, salmon harvests during the early part of the season were predominantly sockeye salmon (Figure 9). As the season progressed, coho and other salmon become a larger component of the harvest. Coho salmon were the dominant species in the harvest after 8 August.

Significant differences ($P < 0.05$) in age composition of harvested coho salmon occurred between fisheries during 1988 (Appendix Tables 1-4). However, in all sampled fisheries, age 2.1 coho salmon dominated the harvests (Figure 10). Differences also occurred in the mean length-at-age of harvested coho salmon by fishery (Figure 10, Appendix Tables 5 through 8).

There is evidence that the gear used in the commercial fisheries is selective for smaller sized coho salmon. The most common size gill net used in the Inlet is 13.7 cm (5 3/8") mesh. This mesh size is used to target sockeye salmon. To evaluate the selectivity of this gear on coho salmon, a selectivity curve for sockeye salmon (we could not find a selectivity curve for coho salmon) for a 13.7 cm mesh gill net (Brannian 1982) was plotted against a length frequency of harvested coho salmon in the sampled fisheries (Figure 11). The resulting plot suggests that the gear used in the commercial fisheries is selective towards smaller sized coho salmon.

1988 Freshwater Escapements

Only limited data are available to evaluate the proportional contribution of drainages to the total escapement of coho salmon to upper Cook Inlet. The information that is available indicates that the major drainages supporting coho salmon in the Northern District are the Susitna (Thompson et al. 1986) and Little Susitna Rivers (Bartlett and Conrad 1988) and the Kenai (Hammerstrom 1988) and Swanson (USFWS unpublished data) Rivers in the Central District. Timing data collected during 1988 suggest that there are significant differences in the entry timing of coho salmon into these major drainages (Figure 12). Coho salmon bound for the Northern District drainages (i.e., the Susitna and Little Susitna Rivers) enter earlier than do coho salmon bound for Kenai Peninsula drainages (i.e., the Kenai and Swanson Rivers).

Significant differences ($P < 0.05$) in age composition of harvested coho salmon also occurred between freshwater collection sites during 1988 (Appendix Tables 9 through 22). However, as was the case for the sampled commercial fisheries, age 2.1 coho salmon dominated the harvests in all sampled escapements. Differences did occur, however, in the proportions of age 1.1 and 3.1 coho salmon returning to Kenai Peninsula and Northern District drainages (Figure 13). A higher proportion of age 3.1 and a lower proportion of age 1.1 coho salmon returned to Kenai Peninsula drainages than returned to Northern District drainages.

Differences also occurred in the mean length-at-age of harvested coho salmon by drainage (Appendix Tables 23 through 36). As was the case with age composition data, the coho salmon that returned to Kenai Peninsula drainages were generally larger over all age classes than coho salmon that returned to Northern District drainages (Figure 13). The observed differences in mean

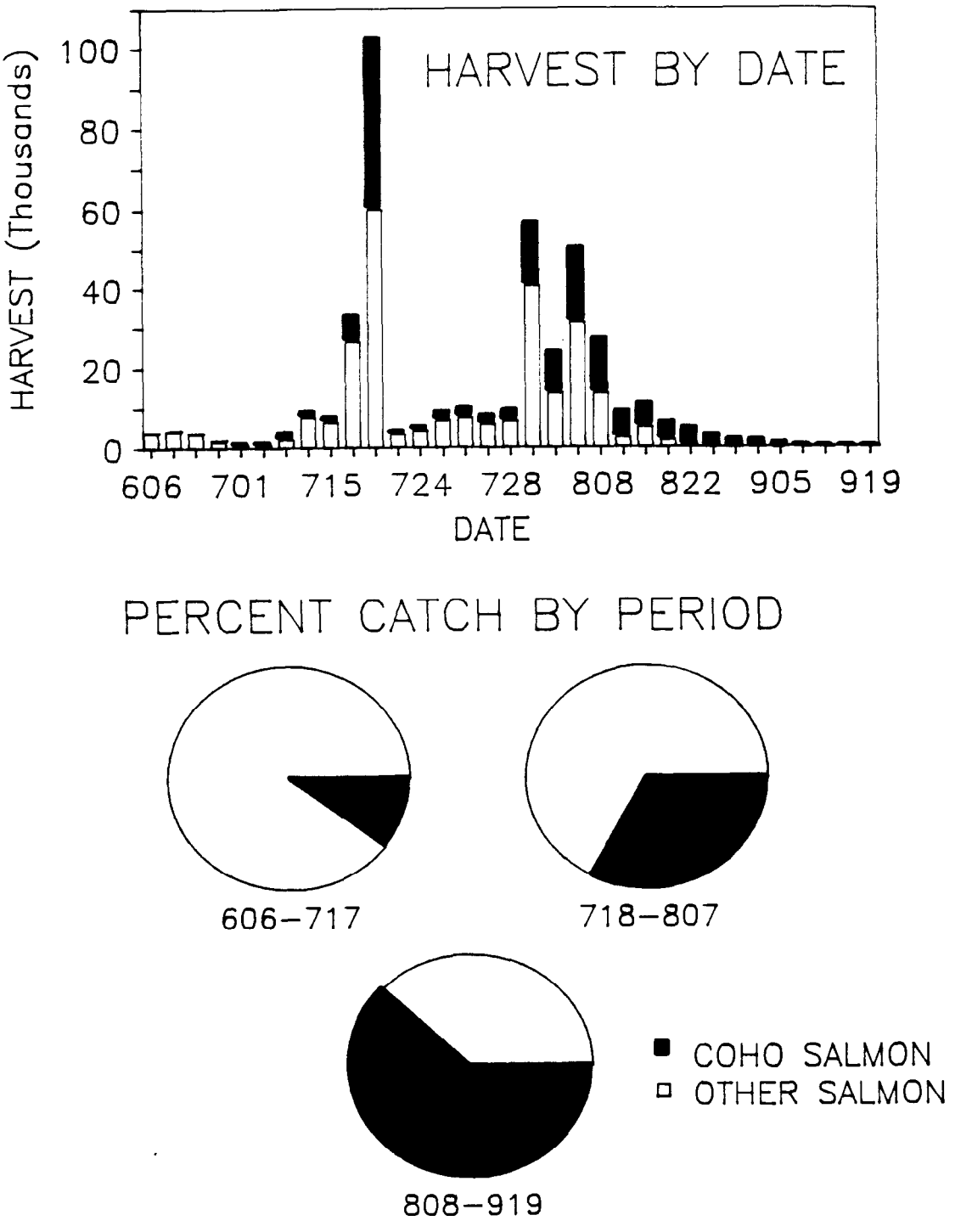

Figure 9. Species compositions of the harvests in the Northern District west-side set net fisheries over time during 1988.

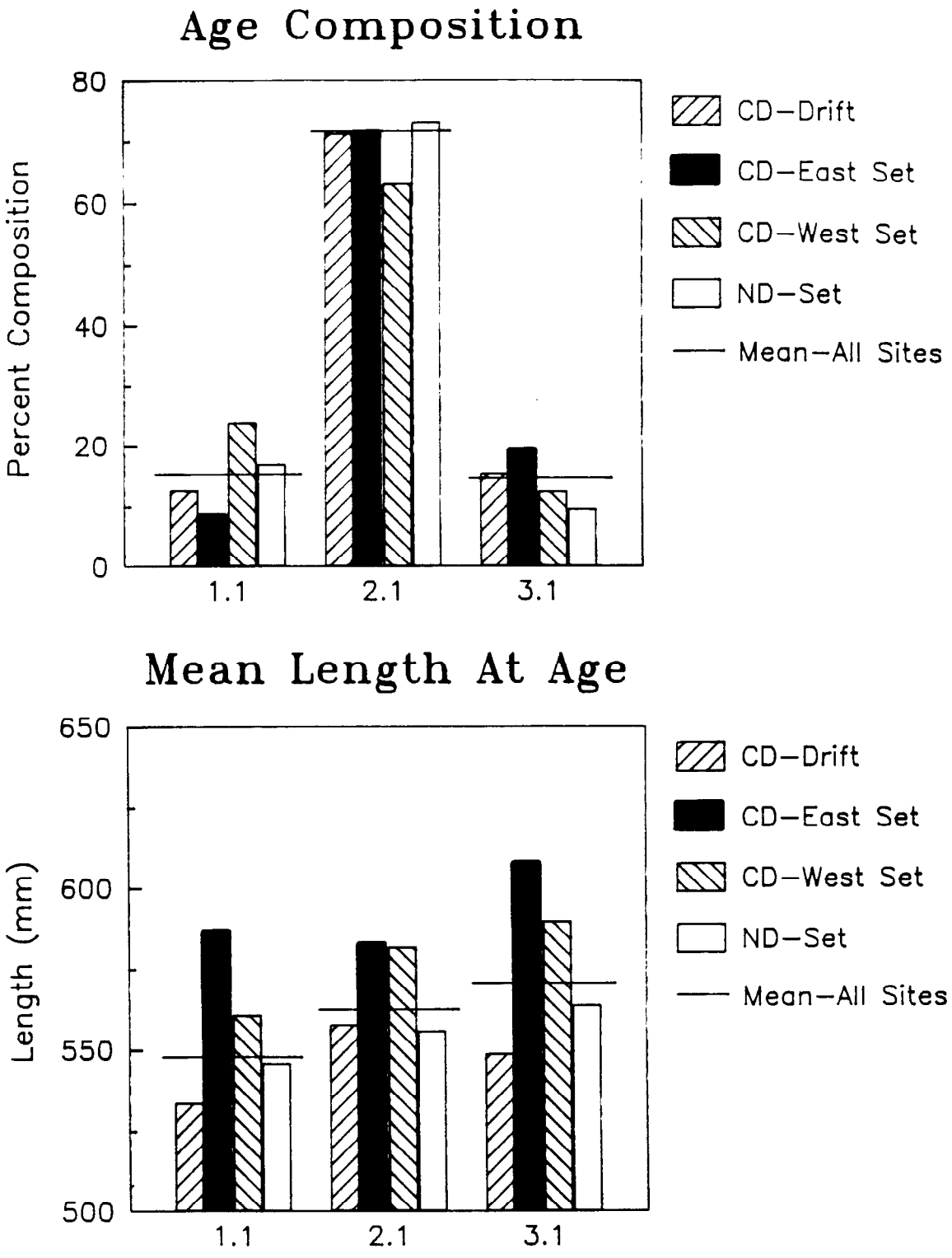

Figure 10. Age composition and mean length-at-age statistics for coho salmon harvested in selected upper Cook Inlet commercial fisheries during 1988.

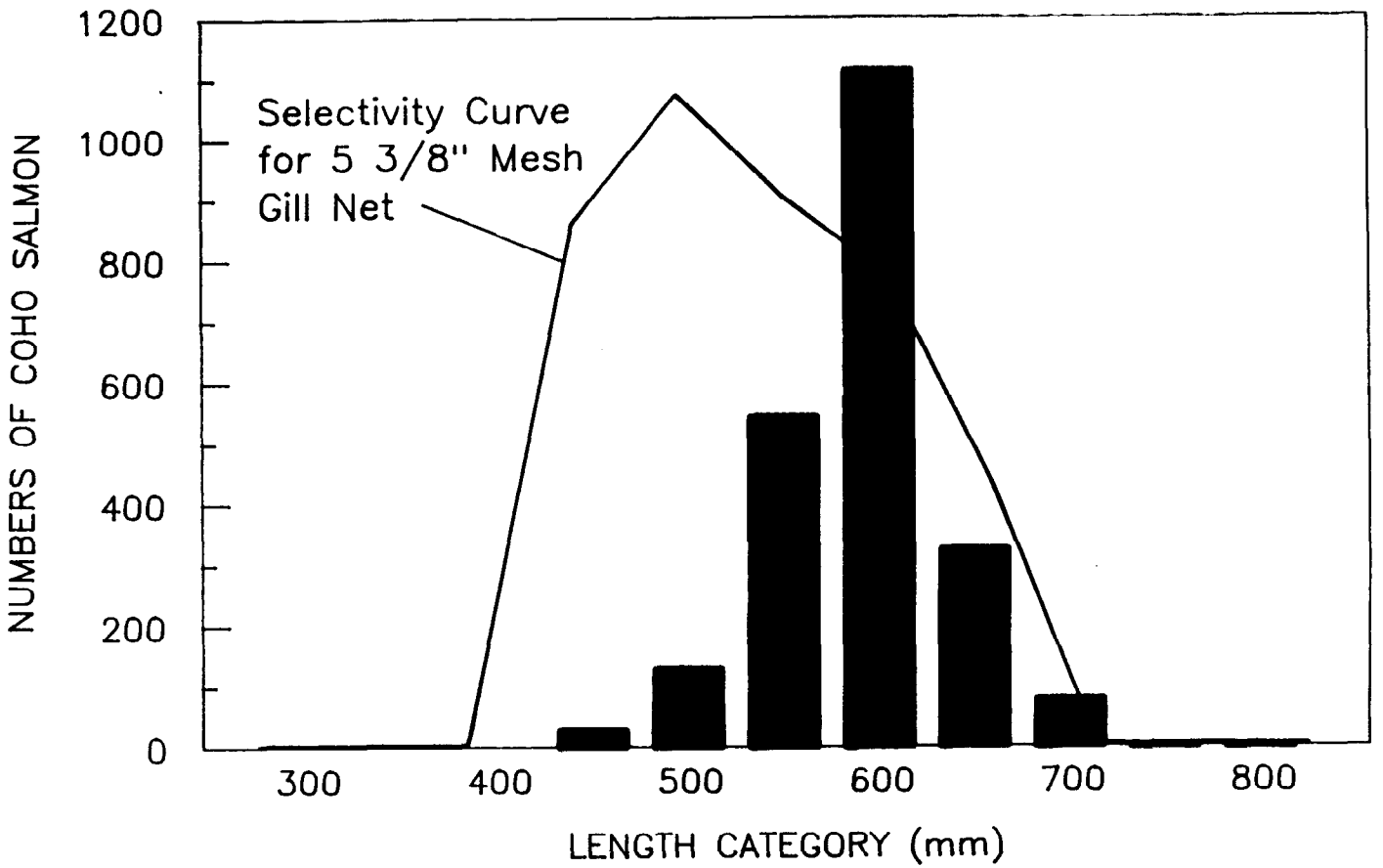

Figure 11. Length frequency of coho salmon harvested in selected upper Cook Inlet commercial fisheries during 1988 in comparison to a selectivity curve for 13.7 cm (5 3/8") mesh gill net.

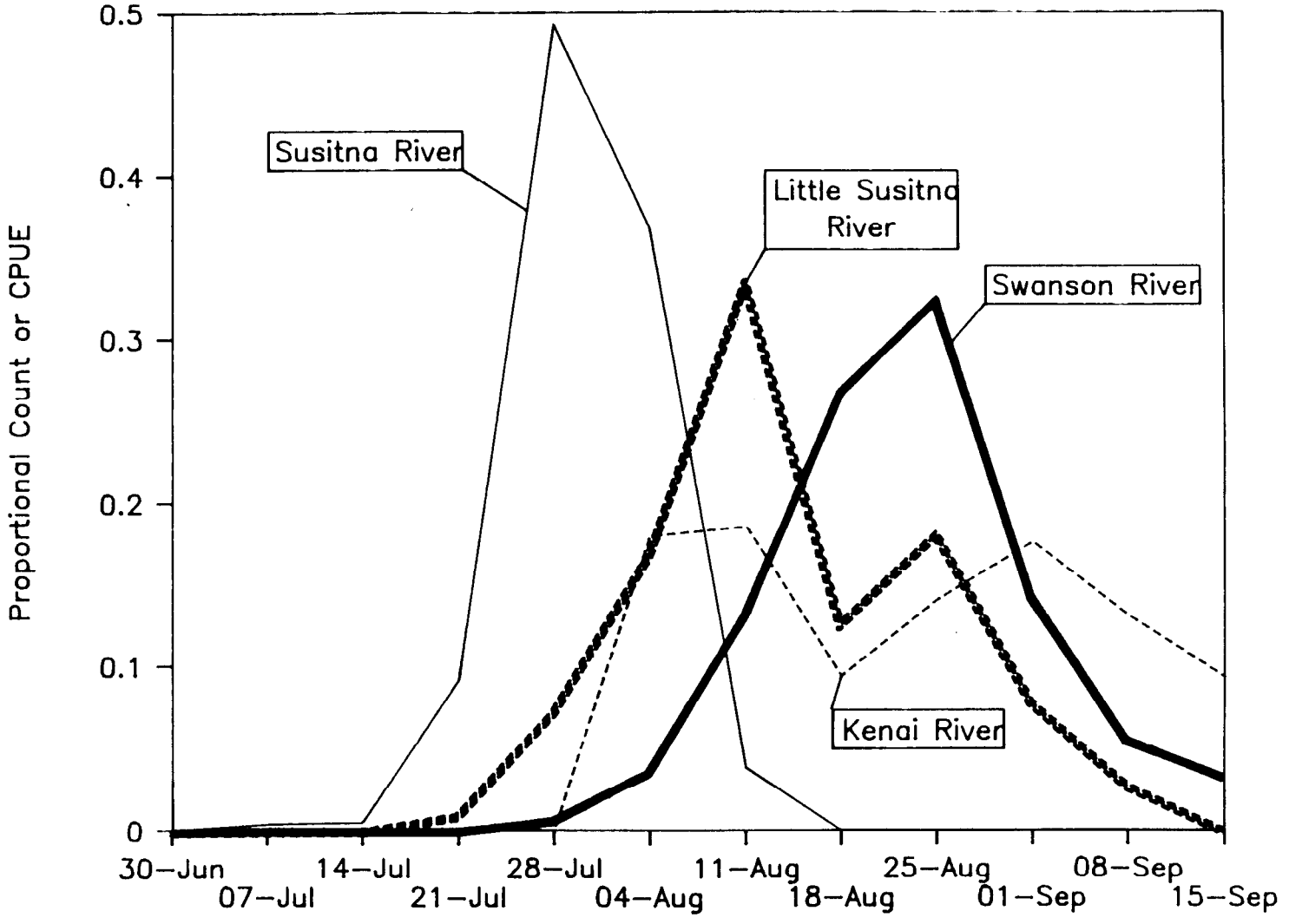

Figure 12. Proportional timing of coho salmon entry into the Susitna, Little Susitna, and Swanson Rivers (weir counts) and the Kenai River (catch per unit effort in the lower river sport fishery) during 1988.

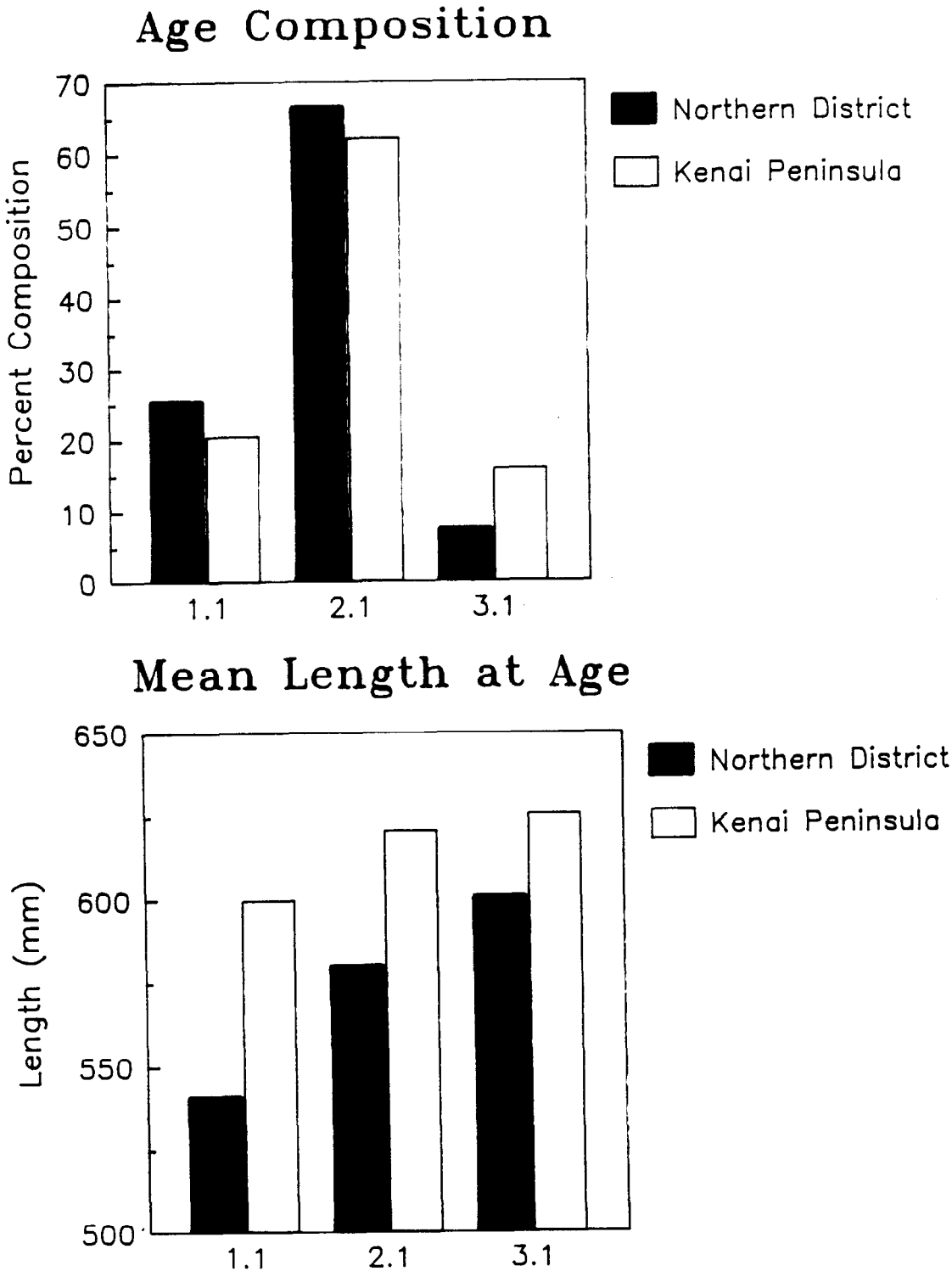

Figure 13. Age composition and mean length-at-age statistics for coho salmon escapements in selected Northern District and Kenai Peninsula drainages of upper Cook Inlet during 1988.

length-at-age statistics between the two drainages may in part be attributable to some of the Northern District fish (a portion of the fish sampled in the Susitna River) which were collected using fishwheels, a gear that has been shown to be selective towards smaller sized coho salmon (Thompson et al. 1986).

Harvest Apportionment

Probable hypotheses regarding the identity of the stock-specific origins of coho salmon harvested in the mixed-stock commercial fisheries of upper Cook Inlet can be generated using the timing and biological information collected during 1988. Analysis of the timing information suggest that many of the coho salmon harvested in the Central District drift net and Northern District west-side set net fisheries are composed of fish returning to the Susitna and Little Susitna Rivers (Figure 14). Harvests of coho salmon in the Central District drift net fishery peaked during the week of 14 July. One week later, harvests of coho salmon peaked in the Northern District west-side set net fisheries. One to 2 weeks later, counts of coho salmon entering the Susitna and Little Susitna Rivers peaked. This information suggests that there is a movement of coho salmon from the Central District to the Northern District during this period. Thus, based on this information, we hypothesize that a majority of the coho salmon harvested during the peak components of the Central District drift net and Northern District west-side set net fisheries originate from the Northern District, in particular the Susitna River.

In contrast, we hypothesize that a majority of the coho salmon harvested during the peak components of the Central District east-side and west-side set net fisheries originate from the Kenai Peninsula, in particular the Kenai and Swanson Rivers (Figure 15). Harvests of coho salmon in the Central District east-side and west-side set net fisheries peaked during the week of 4 August. One to 2 weeks later, catch rates and counts of coho salmon entering the Kenai and Swanson Rivers, respectively, peaked. This information suggests that there is a movement of coho salmon from the Central District into the Kenai Peninsula Rivers during this period.

These hypotheses are supported in the age composition information. Harvests of coho salmon in the Central District drift net and Northern District west-side set net fisheries have age compositions that closely mimic those observed in the Susitna River escapements whereas harvests of coho salmon in the Central District east-side and west-side set net fisheries have age compositions that closely mimic those observed in the Kenai River (Figures 10 and 13).

Similar trends are also observed in the length-at-age information. Coho salmon harvested in the Central District drift net and Northern District west-side set net fisheries have length-at-age statistics that more closely mimic those observed in the Susitna River escapements whereas coho salmon harvests in the Central District east-side and west-side set net fisheries have length-at-age statistics that more closely mimic those observed in the Kenai River (Figures 10 and 13). This is especially evident for the 1.1 and 3.1 age classes.

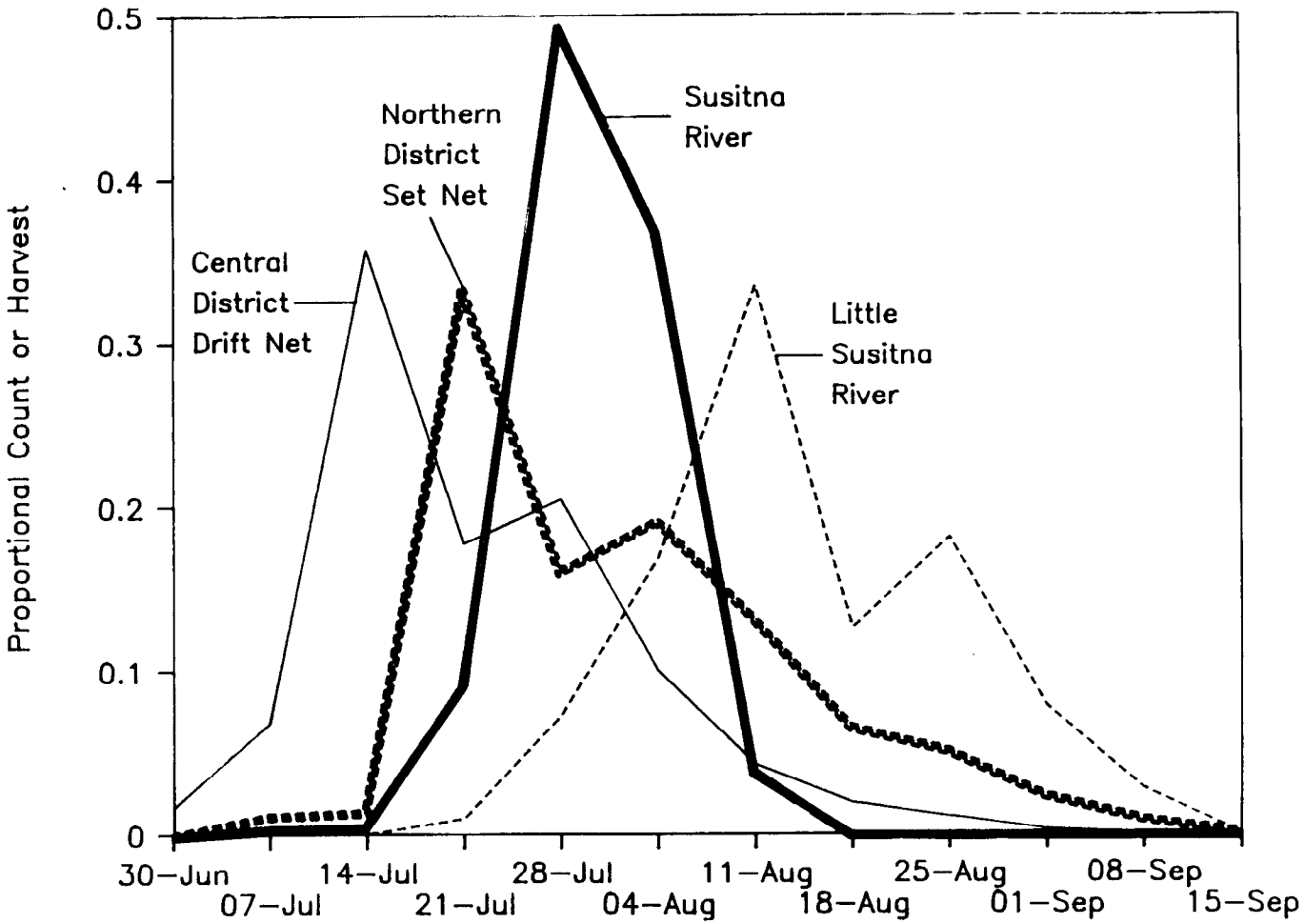

Figure 14. Proportional timing of harvests in the Central District drift net and Northern District west-side set net fisheries (harvest per unit effort) in comparison to entry timing in the Susitna and Little Susitna Rivers (weir counts) during 1988.

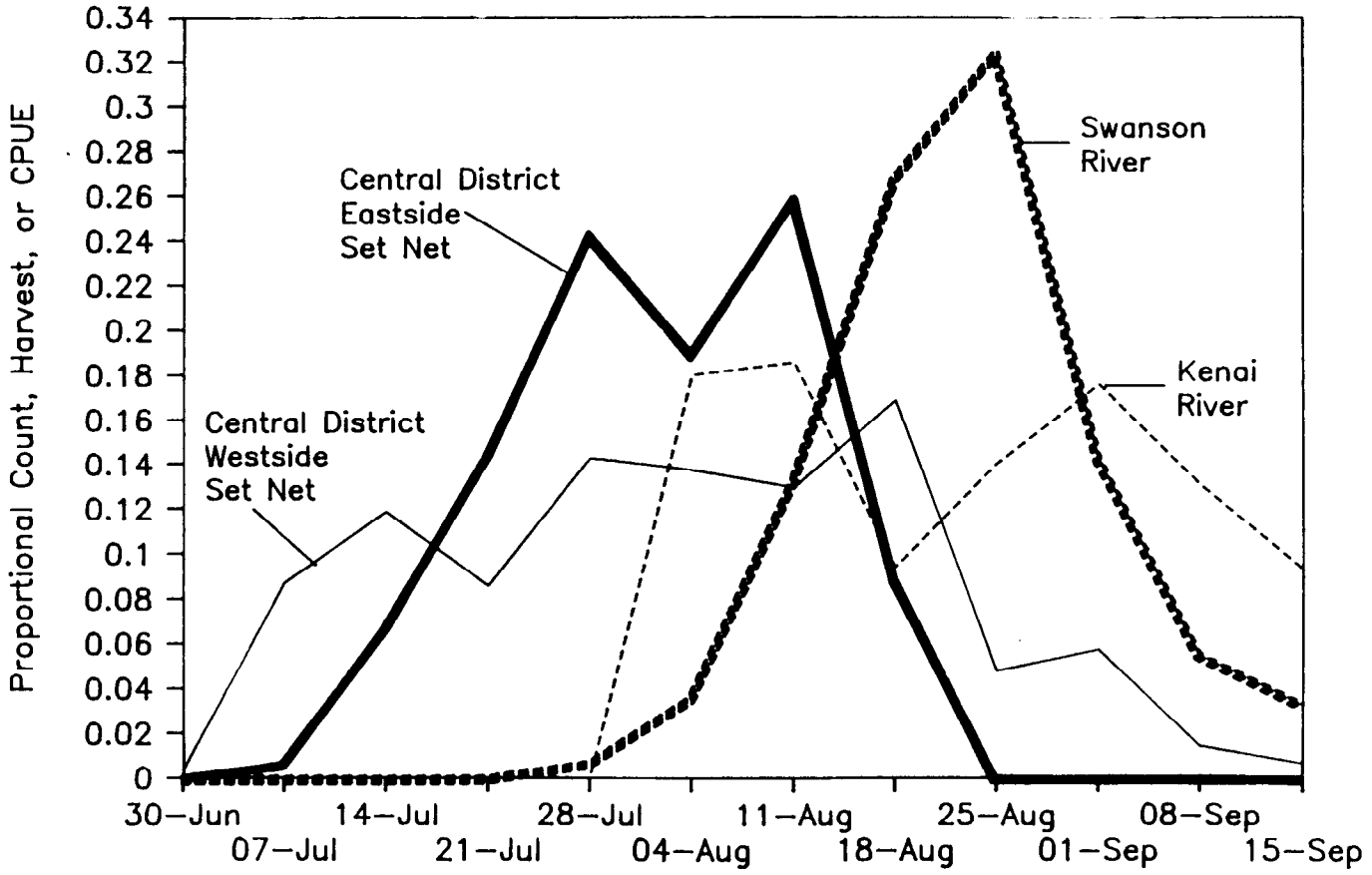

Figure 15. Proportional timing of harvests in the Central District east-side and west-side set net fisheries (harvest per unit effort) in comparison to timing of entry into the Swanson (weir counts) and Kenai River (catch per unit effort in the lower river sport fishery) during 1988.

Thus, based on available timing and biological information, we hypothesize that:

1. A majority of the coho salmon harvested during the peak components of the Central District drift net and Northern District west-side set net fisheries originate from the Northern District, in particular the Susitna River; and

2. A majority of the coho salmon harvested during the peak components of the Central District east-side and west-side set net fisheries originate from the Kenai Peninsula, in particular the Kenai and Swanson Rivers.

We evaluated the feasibility of using length-at-age statistics to quantify these hypotheses. Based on a consideration of known biases in the data (e.g., samples from the Eklutna hatchery were not considered for further analyses as the hatchery fish from this Northern District tributary were overly represented from the samples collected in comparison to their respective abundance), samples of known origin (standards) from Northern District and Kenai Peninsula streams were developed for application to each commercial fishery.

For the Northern District, we developed standards for the Susitna and Little Susitna Rivers, as these two drainages support the largest escapements of coho salmon into this area of upper Cook Inlet. For the Susitna River, we used the combined length-at-age data base for coho salmon sampled at the Yentna River fishwheel and Susitna Landing creel locations[2]. We felt that these locations most accurately reflected the escapement of coho salmon into the Susitna River. For the Little Susitna River, we choose to use the combined length-at-age data base for the weir and creel surveys[2].

For the Kenai Peninsula, we developed standards for the Kenai and Swanson Rivers, as these two drainages support the largest escapements of coho salmon into this area of upper Cook Inlet. For the Kenai River, we used the length-at-age data base for coho salmon sampled in the creel surveys. For the Swanson River, we used the length-at-age data base for coho salmon sampled at the weir. For both systems, we constructed standards for the time periods before and after 1 September to account for the duration of availability that coho salmon would be available to the Central District drift net and Northern District west-side set net fisheries. This stratification was not necessary for these Northern District streams, since all data collections in the Susitna and Little Susitna Rivers occurred before 1 September.

Plots showing mean length-at-age with associated 95% confidence intervals for each fishery and samples of known origin that could potentially contribute fish to that fishery based on duration of availability data were used to determine probable stock groupings for these analyses (Figures 16 through 19). These plots generally support the initial hypothesis that a large

[2] The age compositions of these two collections sites were not significantly different ($P > 0.05$).

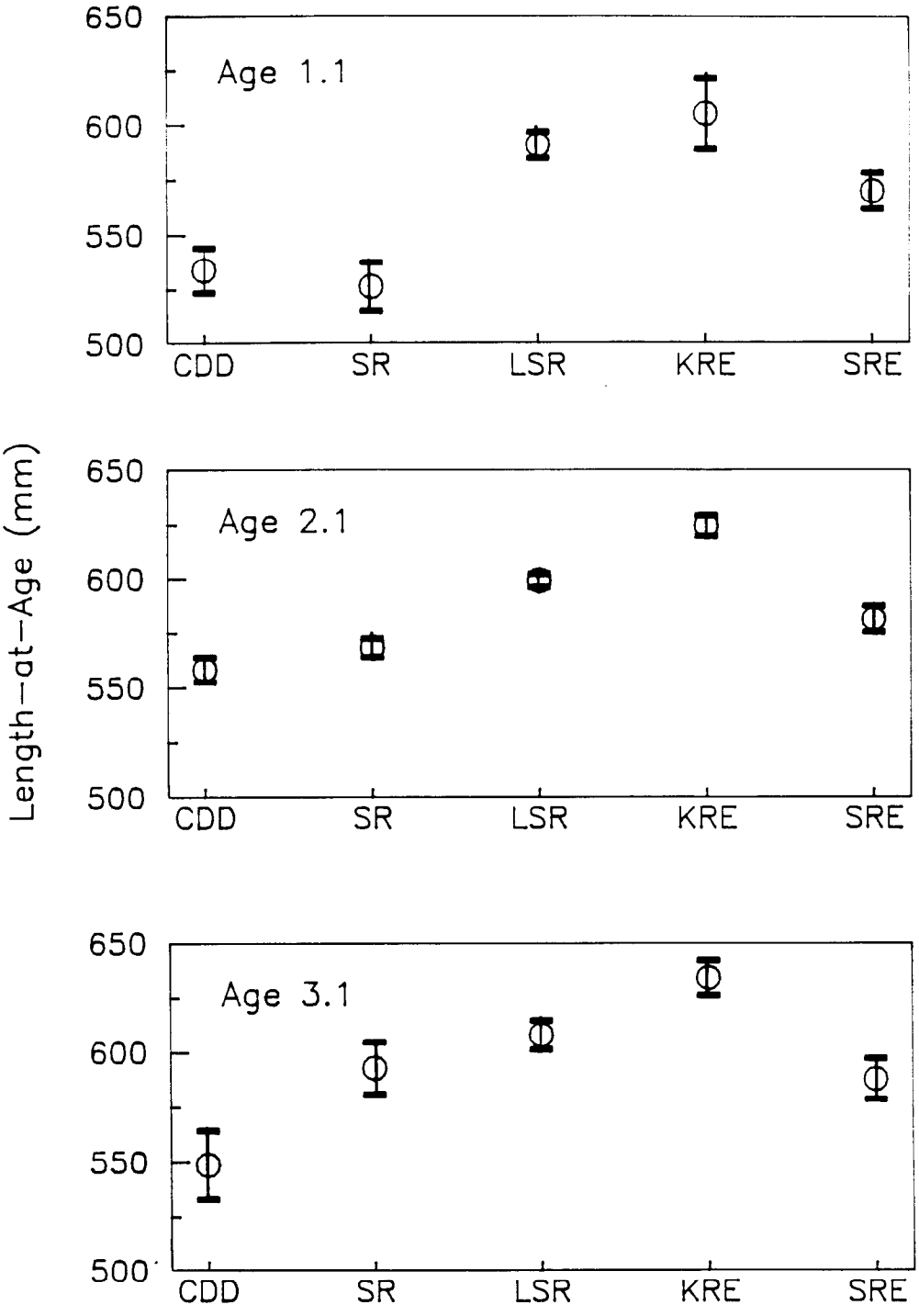

Figure 16. Length-at-age statistics for coho salmon harvested in the Central District drift net fishery (CDD) in comparison to length-at-age statistics for coho salmon escapements into the Susitna (SR) and Little Susitna (LSR) Rivers and early-run Kenai (KRE) and Swanson (SRE) Rivers.

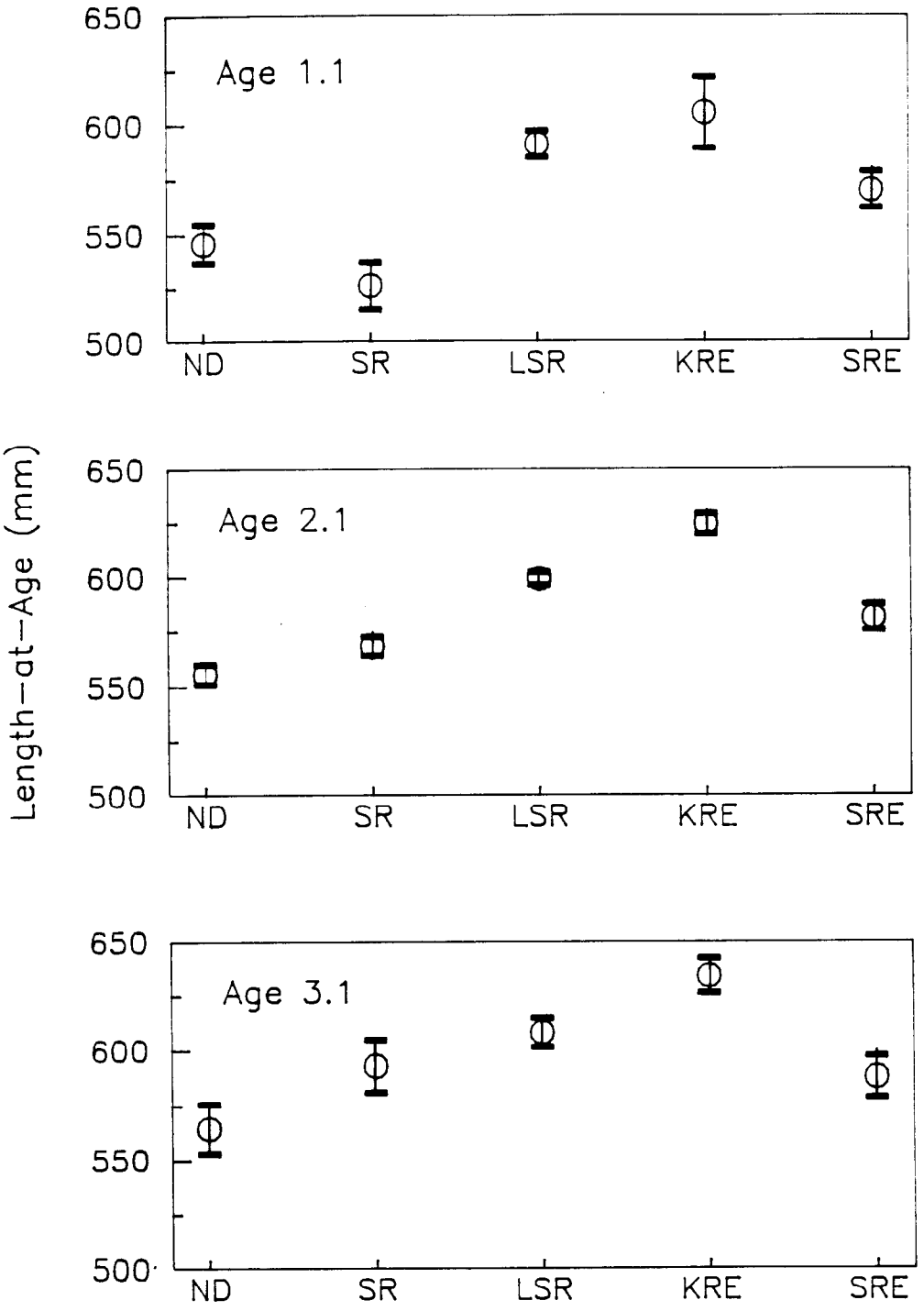

Figure 17. Length-at-age statistics for coho salmon harvested in the Northern District west-side set net fishery (ND) in comparison to length-at-age statistics for coho salmon escapements into the Susitna (SR) and Little Susitna (LSR) Rivers and early-run Kenai (KRE) and Swanson (SRE) Rivers.

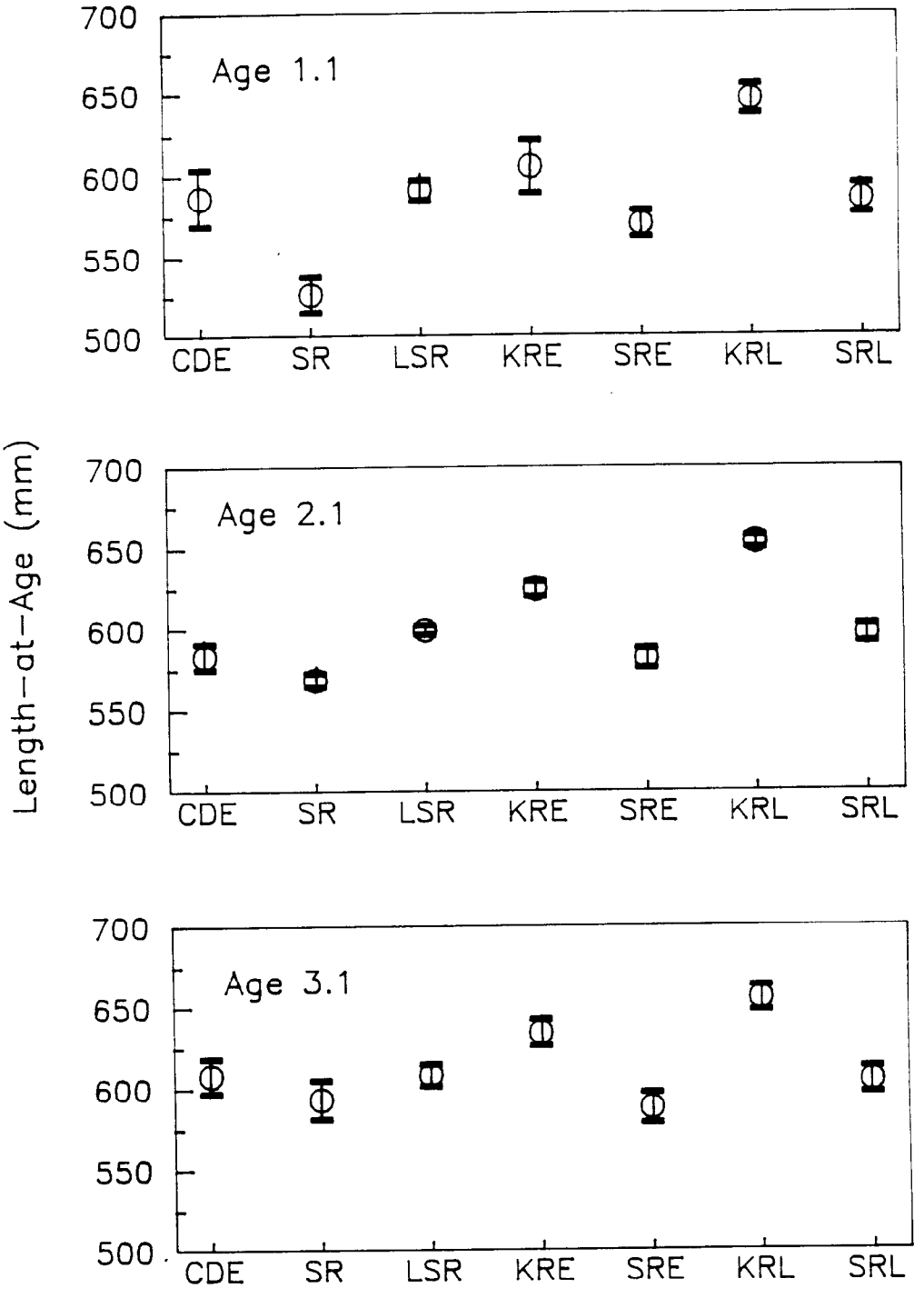

Figure 18. Length-at-age statistics for coho salmon harvested in the Central District east-side set net fishery (CDE) in comparison to length-at-age statistics for coho salmon escapements into the Susitna (SR) and Little Susitna (LSR) Rivers, early-run Kenai (KRE) and Swanson (SRE) Rivers, and late-run Kenai (KRL) and Swanson (SRL) Rivers.

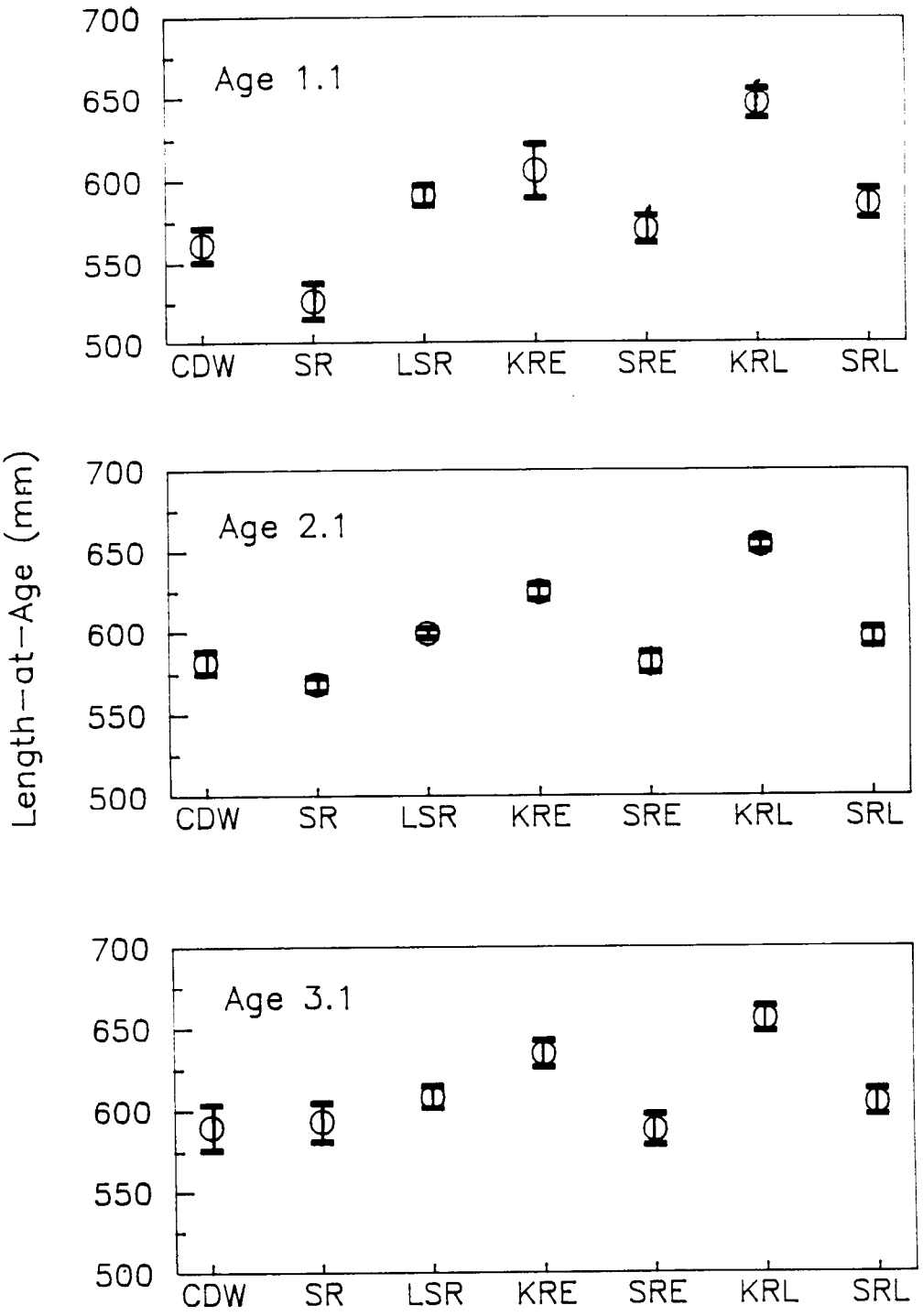

Figure 19. Length-at-age statistics for coho salmon harvested in the Central District west-side set net fishery (CDW) in comparison to length-at-age statistics for coho salmon escapements into the Susitna (SR) and Little Susitna (LSR) Rivers, early-run Kenai (KRE) and Swanson (SRE) Rivers, and late-run Kenai (KRL) and Swanson (SRL) Rivers.

majority of the coho salmon harvested during the peak components of the Central District drift net and Northern District west-side set net fisheries originate from the Northern District. An exception is that coho salmon from the Little Susitna River have length-at-age statistics that more closely resemble those for coho salmon of Kenai Peninsula origin and coho salmon from the Swanson River have length-at-age statistics that appear to fall between those for the Susitna and Kenai Rivers. However, since both these streams have escapements that are at least an order of magnitude less than those for their companion streams in each drainage, we still believe that our initial hypothesis is generally correct.

These plots, however, do not appear to support the hypothesis that a majority of the coho salmon harvested during the peak components of the Central District east-side and west-side set net fisheries originate from the Kenai Peninsula. Based on the length-at-age statistics, these commercial fisheries apparently harvest mixed stocks of Northern District and Kenai Peninsula coho salmon.

Because of the large differences in mean length-at-age between drainages and the small errors around these differences, any discriminate model based on these length-at-age data would lead to a large majority of the Central District drift net and Northern District west-side set net harvests being assigned to the Susitna River. The power of the model would be decreased for the Central District west-side and east-side set net fisheries, but these fisheries harvest a magnitude less fish than do the Central District drift net and Northern District west-side set net fisheries, and as such would be of lesser value.

Unfortunately there are also mitigating factors against these hypotheses observed in these data. As can be seen in Figures 15 and 16, the length-at-age statistics for age 3.1 coho salmon in the Central District drift net and Northern District west-side set net fisheries were smaller than any of the possible contributing stocks to these fisheries. There are several possible explanations for this. First, some other stocks contributed to these harvests. We consider this unlikely in that, to our knowledge, there are no other major stocks that could contribute to such a degree to cause this discrepancy. Second, the commercial gear used to harvest coho salmon in these two commercial fisheries is selective towards smaller sized coho salmon. We feel that this explanation is possible, especially in light of the gear selectivity data depicted in Figure 11.

If the gear used in the commercial fishery is significantly selective for smaller sized fish, the results we have shown to support our two hypotheses regarding the stock origins of the mixed-stock harvests in the commercial fisheries may be in question. If true, observed differences in length-at-age statistics between drainages may not be the result of genetic length-at-age differences between stocks but rather the result of selectivity of the commercial gear used to harvest salmon in upper Cook Inlet. Therefore, coho salmon escapements to Kenai Peninsula drainages may appear to have larger length-at-age statistics than fish that escape to Susitna River drainages due to the duration of time the coho salmon are subject to the commercial gear. This could happen if all stocks of coho salmon enter upper Cook Inlet at

about the same time and Northern District coho salmon stocks enter the rivers earlier than do Kenai Peninsula stocks. We do know that coho salmon stocks enter Northern District streams earlier than do coho stocks that enter Kenai Peninsula streams; however, we do not know whether all of these stocks enter upper Cook Inlet at the same time.

Thus, we are left with two alternative hypotheses that, at the present, we cannot distinguish between:

1. Observed differences in length-at-age statistics between stock-specific, terminal locations are the result of genetic and/or environmental differences. If this hypothesis is true, it follows that the observed differences in timing to terminal locations actually reflect differences in the time of entry into the various commercial fisheries and, given this, that the observed differences in length-at-age statistics may be used to quantify the stock-specific origins of the mixed-stock harvests in the commercial fisheries.

2. Differences in length-at-age statistics in terminal locations are the result of gear selectivity in the marine commercial fisheries. If this hypothesis is true, it follows that the observed differences in timing to terminal locations do not actually reflect differences in the time of entry into the various commercial fisheries and, given this, that the observed differences in length-at-age statistics could not be used to quantify the stock-specific origins of the mixed-stock harvests in the commercial fisheries.

As an alternative approach, we choose to evaluate scale patterns as a tool to identify and quantify the stock-specific origins of coho salmon harvested in the mixed-stock commercial fisheries. The first step in this analysis was to identify scale pattern variables that are not significantly correlated with fish size. If a specific scale pattern variable is significantly correlated with fish size, then we fall into the same problem as with the length-at-age analyses. As an initial test, we measured the correlation between the widths of the freshwater and marine zones of a random subsample of 50 fish from the freshwater escapements of the Susitna and Kenai Rivers and the lengths of the fish (Figure 20). We found that the width of the freshwater scale zone was not significantly correlated ($P > 0.05$) to the length of the fish for both the Kenai and Susitna River samples, suggesting that this variable holds promise as a discriminate variable. Unfortunately, there did not appear to be a measurable difference in the widths of the zones between the drainages (Figure 20). It may be that there are differences in scale growth patterns within the freshwater zone of the scales between the drainages that could be used as a discriminate variable. For the marine growth zone (Figure 21), the width of the marine zone was significantly ($P < 0.05$) correlated to the length of the fish in both the Susitna and Kenai Rivers. Thus, we conclude that scale pattern variables from the marine growth zones are probably inappropriate for further analyses, at least until the discrepancy between hypotheses 1 and 2 above is resolved.

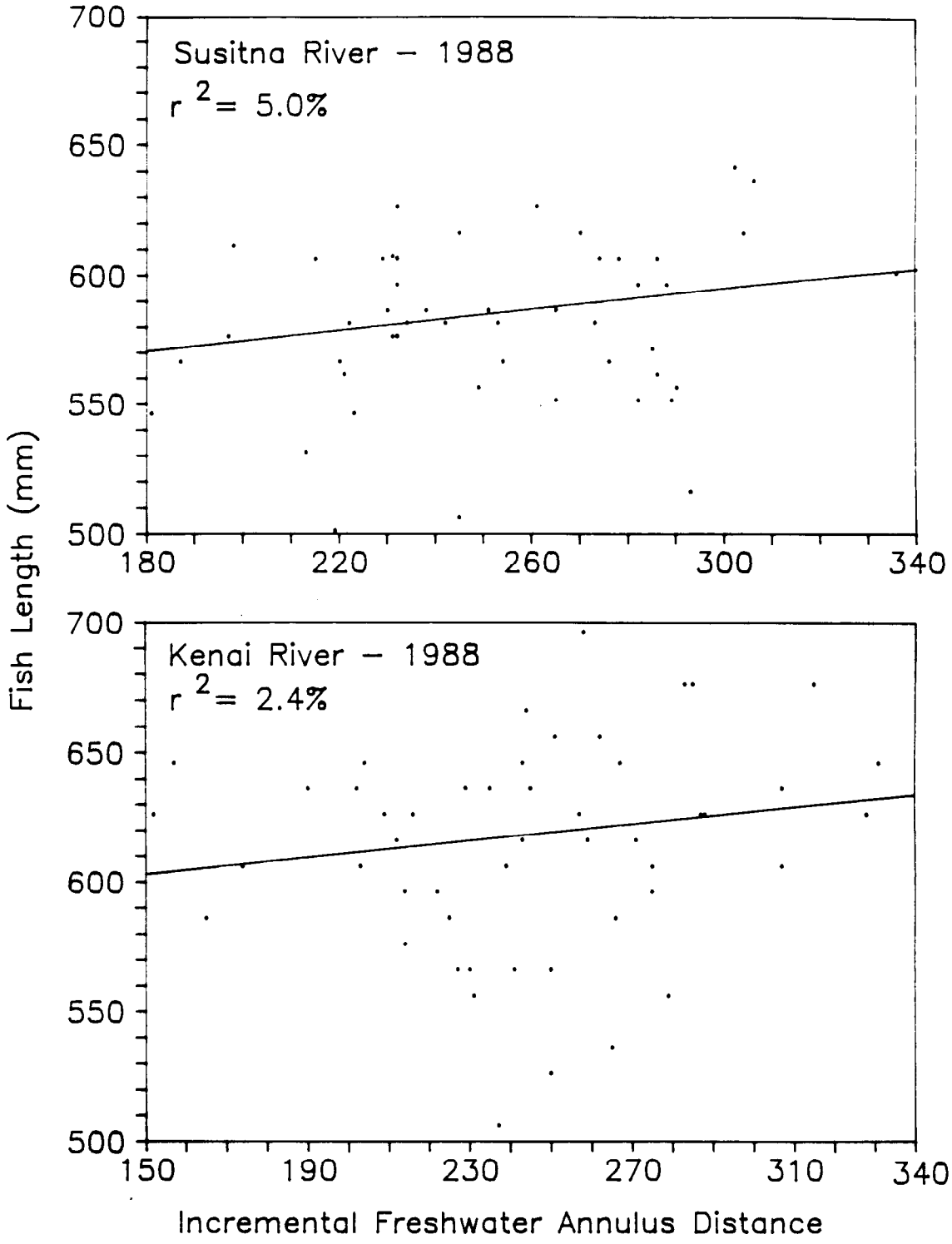

Figure 20. Relationship between the length of a sampled coho salmon in the Kenai and Susitna River escapements to the width of its freshwater scale zone.

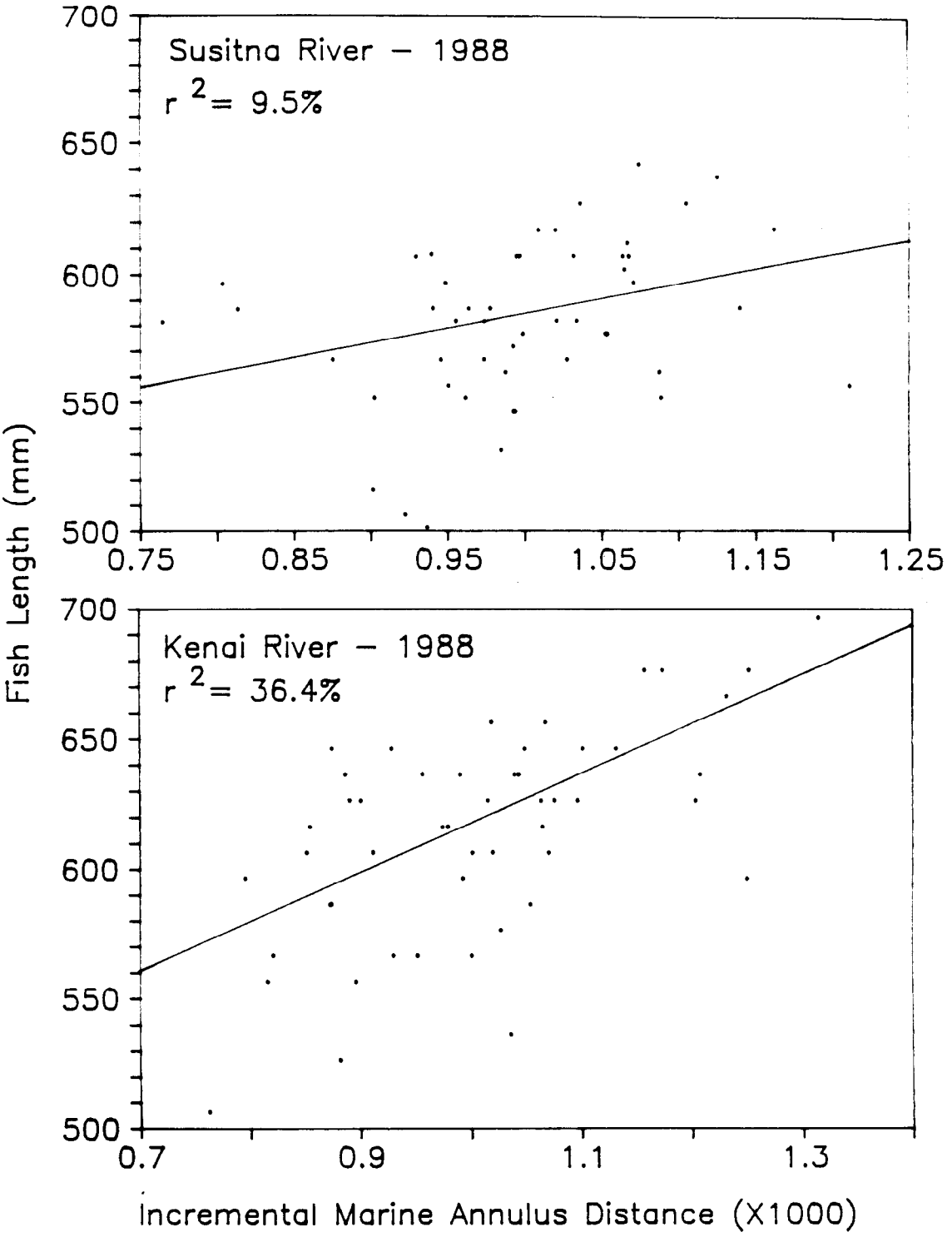

Figure 21. Relationship between the length of a sampled coho salmon in the Kenai and Susitna River escapements to the width of its marine scale zone.

DISCUSSION

Available timing and length-at-age statistics indicate that a majority of the coho salmon harvested in the Central District drift net and Northern District set net fisheries originate from Northern District streams, in particular the Susitna River. These data also indicate that coho salmon harvested in the Central District west-side and east-side set net fisheries originate from a mixture of Kenai Peninsula and Northern District streams. However, because of likely selectivity of the commercial gear for smaller coho salmon, it is not possible to quantify these differences with length-correlated statistics at this time.

To test whether the observed differences in length-at-age are genetic and not an artifact of gear selectivity, it will be necessary to conduct further investigations. These investigations can take a variety of approaches including:

1. A more complete analysis of scale patterns to identify if there are specific freshwater scale variables that are not correlated with fish length but may offer adequate discriminatory power to distinguish stock groupings.

2. A tagging study to evaluate the entry pattern and marine residency time of coho salmon in upper Cook Inlet waters.

3. A coded wire tagging investigation to identify the stock origins of coho salmon in the mixed stock marine fisheries.

Since collection of length and age data are a part of the Department's existing monitoring program, we recommend that option 1 be pursued at this time before beginning research into options 2 and 3.

ACKNOWLEDGEMENTS

The authors wish to thank Dave Bernard and Marianna Alexandersdottir for the help with data analyses. The authors would also like to thank the Commercial Fisheries staff for their assistance in providing harvest and biological data. We would also like to acknowledge the funding provided through the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-4, Job No. S-32-12.

LITERATURE CITED

Bartlett, L. and R. Conrad. 1988. Effort and catch statistics for the sport fishery for coho salmon in the Little Susitna River with estimates of escapement, 1988. Alaska Department of Fish and Game, Fishery Data Series No. 51. 61 pp.

Bethe, M. 1977. Memo to Dave Daisy re: Cook Inlet coho analysis, 1977. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska. 3 pp.

Brannian, L. K. 1982. The estimation of daily escapement and total abundance from catch per unit effort of the sockeye salmon fishery in Togiak Bay, Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 206. 129 pp.

Clutter, J. E. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Fishery Commission. Bulletin 9. 159 pp.

Hammarstrom, S. L. 1988. Angler effort and harvest of chinook salmon and coho salmon by the recreational fisheries in the lower Kenai River, 1987. Alaska Department of Fish and Game, Fishery Data Series No. 50. 87 pp.

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52. 95 pp.

MINITAB, Inc. 1988. MINITAB reference manual, release 6. MINITAB, Inc, State College, PA. 341 pp.

Mundy, P. R. 1982. Migratory timing of adult chinook salmon (*Oncorhynchus tshawytscha*) in the lower Yukon River, Alaska with respect to fisheries management. Technical Report No. 82-1. Department of Oceanography. Old Dominion University. Norfolk, VA. 52 pp.

Robertson, T. 1979. Memo to distribution re: 1978 Cook Inlet coho salmon pattern analysis. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska. 9 pp.

Ryan, P. and M. Christie. Scale reading equipment. Fisheries and Marine Services, Canada. Technical Report PAC/T-75-8. Manaimo, B.C.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1979. Elementary survey sampling. Duxbury Press, North Scituate, MA. 278 pp.

Tarbox, K. E. 1988. Migratory rate and behavior of salmon in upper Cook Inlet, Alaska, 1983-1984. Alaska Department of Fish and Game, Fishery Research Bulletin 88-05. 56 pp.

Thompson, F. M., S. N. Wick, and B. L. Stratton. 1986. Adult salmon investigations: May - October 1985. Susitna Aquatic Studies Program. Report No. 13 (Volume 1 of 2). Alaska Department of Fish and Game. Anchorage, AK. APA Document #3412.

Wadman, R. D. 1971. Coho salmon status report. Unpublished report. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage, Alaska. 19 pp.

APPENDIX

Appendix Table 1. Age composition of coho salmon sampled in the Central District drift net fishery during 1988.

Sex	Age Class 2.0	1.1	2.1	3.1	4.1	TOTAL
Males						
Sample Number		71	395	77	2	545
% of Sample		7.7	42.7	8.3	0.2	59.0
Std. Error		0.01	0.02	0.01	0.00	0.02
Females						
Sample Number	1	47	265	66		379
% of Sample	0.1	5.1	28.7	7.1		41.0
Std. Error	0.00	0.01	0.01	0.01		0.02
Both Sexes						
Sample Number	1	118	660	143	2	924
% of Sample	0.1	12.8	71.4	15.5	0.2	100.0
Std. Error	0.00	0.01	0.01	0.01	0.00	

Appendix Table 2. Age composition of coho salmon sampled in the Northern District set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Not Sexed				
Sample Number		1		1
% of Sample		0.2		0.2
Std. Error		0.00		0.00
Males				
Sample Number	56	218	27	301
% of Sample	9.5	37.1	4.6	51.3
Std. Error	0.01	0.02	0.01	0.02
Females				
Sample Number	44	211	30	285
% of Sample	7.5	35.9	5.1	48.6
Std. Error	0.01	0.02	0.01	0.02
Both Sexes				
Sample Number	100	430	57	587
% of Sample	17.0	73.3	9.7	100.0
Std. Error	0.02	0.02	0.01	

Appendix Table 3. Age composition of coho salmon sampled in the Central District east-side set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Males					
Sample Number	16	127	47		190
% of Sample	4.6	36.8	13.6		55.1
Std. Error	0.01	0.03	0.02		0.03
Females					
Sample Number	14	120	20	1	155
% of Sample	4.1	34.8	5.8	0.3	44.9
Std. Error	0.01	0.03	0.01	0.00	0.03
Both Sexes					
Sample Number	30	247	67	1	345
% of Sample	8.7	71.6	19.4	0.3	100.0
Std. Error	0.02	0.02	0.02	0.00	

Appendix Table 4. Age composition of coho salmon sampled in the Central District west-side set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Males					
Sample Number	41	130	26		197
% of Sample	11.3	35.7	7.1		54.1
Std. Error	0.02	0.03	0.01		0.03
Females					
Sample Number	46	100	20	1	167
% of Sample	12.6	27.5	5.5	0.3	45.9
Std. Error	0.02	0.02	0.01	0.00	0.03
Both Sexes					
Sample Number	87	230	46	1	364
% of Sample	23.9	63.2	12.6	0.3	100.0
Std. Error	0.02	0.03	0.02	0.00	

Appendix Table 5. Length-at-age statistics of coho salmon sampled in the Central District drift net fishery during 1988.

Sex	Age Class 2.0	1.1	2.1	3.1	4.1	TOTAL
Males						
Average		535	561	545	632	556
Std. Error		6	3	12		3
Sample Size		38	231	48	1	318
Minimum		442	440	51	632	51
Maximum		594	800	662	632	800
Females						
Average	553	532	551	555		549
Std. Error		9	6	7		4
Sample Size	1	26	107	32		166
Minimum	553	440	53	480		53
Maximum	553	596	660	660		660
Both Sexes						
Average	553	534	558	549	632	554
Std. Error		5	3	8		3
Sample Size	1	64	338	80	1	484
Minimum	553	440	53	51	632	51
Maximum	553	596	800	662	632	800

Appendix Table 6. Length-at-age statistics of coho salmon sampled in the Northern District set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Not Sexed				
Average		568		568
Std. Error				
Sample Size		1		1
Minimum		568		568
Maximum		568		568
Males				
Average	547	561	569	560
Std. Error	6	3	10	3
Sample Size	33	162	20	215
Minimum	473	446	445	445
Maximum	630	662	631	662
Females				
Average	545	549	560	555
Std. Error	6	3	6	3
Sample Size	31	156	22	209
Minimum	446	442	508	442
Maximum	599	662	660	662
Both Sexes				
Average	546	556	564	555
Std. Error	4	2	6	2
Sample Size	64	319	42	425
Minimum	446	442	445	442
Maximum	630	662	660	662

Appendix Table 7. Length-at-age statistics of coho salmon sampled in the Central District east-side set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Males					
Average	592	585	606		592
Std. Error	10	5	6		4
Sample Size	8	79	38		125
Minimum	559	498	500		498
Maximum	642	678	667		678
Females					
Average	581	579	612	588	585
Std. Error	16	7	11		6
Sample Size	7	55	14	1	77
Minimum	494	450	523	588	450
Maximum	620	667	650	588	667
Both Sexes					
Average	587	583	608	588	590
Std. Error	9	4	5		3
Sample Size	15	134	52	1	202
Minimum	494	450	500	588	450
Maximum	642	678	667	588	678

Appendix Table 8. Length-at-age statistics of coho salmon sampled in the Central District west-side set net fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Males					
Average	553	587	588		581
Std. Error	9	4	9		4
Sample Size	22	84	18		124
Minimum	443	422	515		422
Maximum	618	661	661		661
Females					
Average	568	573	592	561	574
Std. Error	5	6	12		4
Sample Size	25	47	11	1	84
Minimum	518	479	533	561	479
Maximum	617	664	663	561	664
Both Sexes					
Average	561	582	590	561	578
Std. Error	5	3	7		3
Sample Size	47	131	29	1	208
Minimum	443	422	515	561	422
Maximum	618	664	663	561	664

Appendix Table 9. Age composition of coho salmon sampled during the Kenai River early-run sport fishery during 1988.

Sex	Age Class 1.1	2.0	2.1	3.1	TOTAL
Females					
Sample Number	22	1	128	28	179
% of Sample	5.1	0.2	29.6	6.5	41.3
Std. Error	0.01	0.00	0.02	0.01	0.02
Males					
Sample Number	15		189	50	254
% of Sample	3.5		43.6	11.5	58.7
Std. Error	0.01		0.02	0.02	0.02
Both Sexes					
Sample Number	37	1	317	78	433
% of Sample	8.5	0.2	73.2	18.0	100.0
Std. Error	0.01	0.00	0.02	0.02	

Appendix Table 10. Age composition of coho salmon sampled during the Kenai River late-run sport fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.0	TOTAL
Females					
Sample Number	29	170	52		251
% of Sample	5.1	30.0	9.2		44.3
Std. Error	0.01	0.02	0.01		0.02
Males					
Sample Number	39	211	64	1	315
% of Sample	6.9	37.3	11.3	0.2	55.7
Std. Error	0.01	0.02	0.01	0.00	0.02
Both Sexes					
Sample Number	68	381	116	1	566
% of Sample	12.0	67.3	20.5	0.2	100.0
Std. Error	0.01	0.02	0.02	0.00	

Appendix Table 11. Age composition of coho salmon sampled at the Russian River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	1	42	7	50
% of Sample	1.0	42.4	7.1	50.5
Std. Error	0.01	0.05	0.03	0.05
Males				
Sample Number	5	41	3	49
% of Sample	5.1	41.4	3.0	49.5
Std. Error	0.02	0.05	0.02	0.05
Both Sexes				
Sample Number	6	83	10	99
% of Sample	6.1	83.8	10.1	100.0
Std. Error	0.02	0.04	0.03	

Appendix Table 12. Age composition of coho salmon sampled at the Swanson River weir during 1988.

	Age Class								
Sex	0	1.1	2.0	2.1	3.0	3.1	4.0	4.1	TOTAL
Females									
Sample Number		105		224		78		1	408
% of Sample		12.8		27.3		9.5		0.1	49.7
Std. Error		0.01		0.02		0.01		0.00	0.02
Males									
Sample Number	1	117	7	212	14	61	1		413
% of Sample	0.1	14.3	0.9	25.8	1.7	7.4	0.1		50.3
Std. Error	0.00	0.01	0.00	0.02	0.00	0.01	0.00		0.02
Both Sexes									
Sample Number	1	222	7	436	14	139	1	1	821
% of Sample	0.1	27.0	0.9	53.1	1.7	16.9	0.1	0.1	100.0
Std. Error	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.00	

Appendix Table 13. Age composition of coho salmon sampled at the Anchor River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	48	66	6	120
% of Sample	17.4	23.9	2.2	43.5
Std. Error	0.02	0.03	0.01	0.03
Males				
Sample Number	71	82	3	156
% of Sample	25.7	29.7	1.1	56.5
Std. Error	0.03	0.03	0.01	0.03
Both Sexes				
Sample Number	119	148	9	276
% of Sample	43.1	53.6	3.3	100.0
Std. Error	0.03	0.03	0.01	

Appendix Table 14. Age composition of coho salmon sampled in the Little Susitna River fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Females					
Sample Number	26	148	35	1	210
% of Sample	6.9	39.5	9.3	0.3	56.0
Std. Error	0.01	0.03	0.02	0.00	0.03
Males					
Sample Number	22	119	24		165
% of Sample	5.9	31.7	6.4		44.0
Std. Error	0.01	0.02	0.01		0.03
Both Sexes					
Sample Number	48	267	59	1	375
% of Sample	12.8	71.2	15.7	0.3	100.0
Std. Error	0.02	0.02	0.02	0.00	

Appendix Table 15. Age composition of coho salmon sampled at the Little Susitna River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	24	118	16	158
% of Sample	7.5	36.6	5.0	49.1
Std. Error	0.01	0.03	0.01	0.03
Males				
Sample Number	22	130	12	164
% of Sample	6.8	40.4	3.7	50.9
Std. Error	0.01	0.03	0.01	0.03
Both Sexes				
Sample Number	46	248	28	322
% of Sample	14.3	77.0	8.7	100.0
Std. Error	0.02	0.02	0.02	

Appendix Table 16. Age composition of coho salmon sampled at the Yentna River fishwheel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	22	67	4	93
% of Sample	9.7	29.6	1.8	41.2
Std. Error	0.02	0.03	0.01	0.03
Males				
Sample Number	35	93	5	133
% of Sample	15.5	41.2	2.2	58.8
Std. Error	0.02	0.03	0.01	0.03
Both Sexes				
Sample Number	57	160	9	226
% of Sample	25.2	70.8	4.0	100.0
Std. Error	0.03	0.03	0.01	

Appendix Table 17. Age composition of coho salmon sampled at the Susitna Landing creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.0	3.1	TOTAL
Females					
Sample Number	27	78		5	110
% of Sample	10.3	29.9		1.9	42.1
Std. Error	0.02	0.03		0.01	0.03
Males					
Sample Number	25	119	2	5	151
% of Sample	9.6	45.6	0.8	1.9	57.9
Std. Error	0.02	0.03	0.01	0.01	0.03
Both Sexes					
Sample Number	52	197	2	10	261
% of Sample	19.9	75.5	0.8	3.8	100.0
Std. Error	0.02	0.03	0.01	0.01	

Appendix Table 18. Age composition of coho salmon sampled at the Talkeetna Landing creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.0	2.1	3.1	TOTAL
Females					
Sample Number	59		114	7	180
% of Sample	15.6		30.2	1.9	47.7
Std. Error	0.02		0.02	0.01	0.03
Males					
Sample Number	55	1	129	12	197
% of Sample	14.6	0.3	34.2	3.2	52.3
Std. Error	0.02	0.00	0.02	0.01	0.03
Both Sexes					
Sample Number	114	1	243	19	377
% of Sample	30.2	0.3	64.5	5.0	100.0
Std. Error	0.02	0.00	0.02	0.01	

Appendix Table 19. Age composition of coho salmon sampled at the Lake Creek creel site on the Susitna River during 1988.

	Age Class						
Sex	1.1	2.0	2.1	3.0	3.1	4.0	TOTAL
Females							
Sample Number	51		162		10		223
% of Sample	11.0		35.1		2.2		48.3
Std. Error	0.01		0.02		0.01		0.02
Males							
Sample Number	44	1	165	4	21	4	239
% of Sample	9.5	0.2	35.7	0.9	4.5	0.9	51.7
Std. Error	0.01	0.00	0.02	0.00	0.01	0.00	0.02
Both Sexes							
Sample Number	95	1	327	4	31	4	462
% of Sample	20.6	0.2	70.8	0.9	6.7	0.9	100.0
Std. Error	0.02	0.00	0.02	0.00	0.01	0.00	

Appendix Table 20. Age composition of coho salmon sampled at the Alexander Creek creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	3	7	1	11
% of Sample	12.5	29.2	4.2	45.8
Std. Error	0.07	0.09	0.04	0.10
Males				
Sample Number	3	10		13
% of Sample	12.5	41.7		54.2
Std. Error	0.07	0.10		0.10
Both Sexes				
Sample Number	6	17	1	24
% of Sample	25.0	70.8	4.2	100.0
Std. Error	0.09	0.09	0.04	

Appendix Table 21. Age composition of coho salmon sampled at the Eklutna Hatchery during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	49	5		54
% of Sample	26.9	2.7		29.7
Std. Error	0.03	0.01		0.03
Males				
Sample Number	120	7	1	128
% of Sample	65.9	3.8	0.5	70.3
Std. Error	0.04	0.01	0.01	0.03
Both Sexes				
Sample Number	169	12	1	182
% of Sample	92.9	6.6	0.5	100.0
Std. Error	0.02	0.02	0.01	

Appendix Table 22. Age composition of coho salmon sampled in miscellaneous upper Cook Inlet west-side streams during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Sample Number	3	15	4	22
% of Sample	5.4	26.8	7.1	39.3
Std. Error	0.03	0.06	0.03	0.07
Males				
Sample Number	5	27	2	34
% of Sample	8.9	48.2	3.6	60.7
Std. Error	0.04	0.07	0.03	0.07
Both Sexes				
Sample Number	8	42	6	56
% of Sample	14.3	75.0	10.7	100.0
Std. Error	0.05	0.06	0.04	

Appendix Table 23. Length-at-age statistics of coho salmon sampled during the Kenai River early-run sport fishery during 1988.

Sex	Age Class 1.1	2.0	2.1	3.1	TOTAL
Females					
Average	596	350	612	626	611
Std. Error	8		4	6	3
Sample Size	22	1	128	28	179
Minimum	530	350	400	580	350
Maximum	670	350	700	710	710
Males					
Average	619		633	639	633
Std. Error	16		3	5	3
Sample Size	15		189	50	254
Minimum	460		520	540	460
Maximum	680		740	720	740
Both Sexes					
Average	605	350	625	634	624
Std. Error	8		2	4	2
Sample Size	37	1	317	78	433
Minimum	460	350	400	540	350
Maximum	680	350	740	720	740

Appendix Table 24. Length-at-age statistics of coho salmon sampled during the Kenai River late-run sport fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.0	TOTAL
Females					
Average	636	648	653		648
Std. Error	7	3	6		2
Sample Size	29	169	51		249
Minimum	520	470	530		470
Maximum	690	710	710		710
Males					
Average	654	658	657	560	657
Std. Error	6	3	6		2
Sample Size	39	209	64	1	313
Minimum	560	520	540	560	520
Maximum	710	760	740	560	760
Both Sexes					
Average	646	654	655	560	653
Std. Error	5	2	4		2
Sample Size	68	378	115	1	562
Minimum	520	470	530	560	470
Maximum	710	760	740	560	760

Appendix Table 25. Length-at-age statistics of coho salmon sampled at the Russian River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	570	613	629	614
Std. Error		6	7	6
Sample Size	1	41	7	49
Minimum	570	450	600	450
Maximum	570	670	655	670
Males				
Average	630	618	653	621
Std. Error	9	6	18	5
Sample Size	5	41	3	49
Minimum	605	520	635	520
Maximum	660	675	690	690
Both Sexes				
Average	620	615	636	618
Std. Error	13	4	8	4
Sample Size	6	82	10	98
Minimum	570	450	600	450
Maximum	660	675	690	690

Appendix Table 26. Length-at-age statistics of coho salmon sampled at the Swanson River weir during 1988.

	Age Class								
Sex	0	1.1	2.0	2.1	3.0	3.1	4.0	4.1	TOTAL
Females									
Average		573		586		600		610	585
Std. Error		5		3		4			2
Sample Size		105		224		77		1	407
Minimum		410		415		470		610	410
Maximum		650		660		660		610	660
Males									
Average	310	577	353	589	320	585	310		571
Std. Error		4	30	3	5	6			4
Sample Size	1	117	7	212	14	60	1		412
Minimum	310	415	295	430	290	445	310		290
Maximum	310	650	530	670	375	660	310		670
Both Sexes									
Average	310	575	353	588	320	594	310	610	578
Std. Error		3	30	2	5	3			2
Sample Size	1	222	7	436	14	137	1	1	819
Minimum	310	410	295	415	290	445	310	610	290
Maximum	310	650	530	670	375	660	310	610	670

Appendix Table 27. Length-at-age statistics of coho salmon sampled at the Anchor River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	624	628	655	628
Std. Error	5	4	16	3
Sample Size	48	66	6	120
Minimum	530	510	620	510
Maximum	680	680	710	710
Males				
Average	610	628	648	620
Std. Error	7	5	7	4
Sample Size	71	82	3	156
Minimum	365	415	635	365
Maximum	700	760	655	760
Both Sexes				
Average	616	628	653	623
Std. Error	4	3	10	3
Sample Size	119	148	9	276
Minimum	365	415	620	365
Maximum	700	760	710	760

Appendix Table 28. Length-at-age statistics of coho salmon sampled in the Little Susitna River fishery during 1988.

Sex	Age Class 1.1	2.1	3.1	4.1	TOTAL
Females					
Average	593	595	604	600	596
Std. Error	7	3	5		2
Sample Size	26	147	35	1	209
Minimum	500	450	520	600	450
Maximum	650	685	660	600	685
Males					
Average	593	602	618		603
Std. Error	8	4	7		3
Sample Size	21	119	24		164
Minimum	520	450	510		450
Maximum	670	670	670		670
Both Sexes					
Average	593	598	610	600	599
Std. Error	5	2	4		2
Sample Size	47	266	59	1	373
Minimum	500	450	510	600	450
Maximum	670	685	670	600	685

Appendix Table 29. Length-at-age statistics of coho salmon sampled at the Little Susitna River weir during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	585	592	591	591
Std. Error	4	3	6	2
Sample Size	24	117	16	157
Minimum	540	490	530	490
Maximum	610	660	630	660
Males				
Average	593	609	622	608
Std. Error	6	3	7	2
Sample Size	22	130	12	164
Minimum	550	500	580	500
Maximum	660	680	670	680
Both Sexes				
Average	589	601	604	599
Std. Error	4	2	6	2
Sample Size	46	247	28	321
Minimum	540	490	530	490
Maximum	660	680	670	680

Appendix Table 30. Length-at-age statistics of coho salmon sampled at the Yentna River fishwheel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	538	560	600	556
Std. Error	9	5	9	4
Sample Size	22	67	4	93
Minimum	450	420	575	420
Maximum	605	625	615	625
Males				
Average	493	558	598	542
Std. Error	11	4	5	5
Sample Size	34	93	5	132
Minimum	315	440	580	315
Maximum	580	630	605	630
Both Sexes				
Average	511	559	599	548
Std. Error	8	3	4	3
Sample Size	56	160	9	225
Minimum	315	420	575	315
Maximum	605	630	615	630

Appendix Table 31. Length-at-age statistics of coho salmon sampled at the Susitna Landing creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.0	3.1	TOTAL
Females					
Average	544	576		568	568
Std. Error	9	4		16	4
Sample Size	27	78		5	110
Minimum	405	470		525	405
Maximum	615	640		615	640
Males					
Average	542	576	353	607	569
Std. Error	11	4	13	10	4
Sample Size	25	119	2	5	151
Minimum	410	400	340	575	340
Maximum	605	645	365	635	645
Both Sexes					
Average	543	576	353	588	568
Std. Error	7	3	13	11	3
Sample Size	52	197	2	10	261
Minimum	405	400	340	525	340
Maximum	615	645	365	635	645

Appendix Table 32. Length-at-age statistics of coho salmon sampled at the Talkeetna Landing creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.0	2.1	3.1	TOTAL
Females					
Average	556		570	584	566
Std. Error	5		3	15	3
Sample Size	59		114	7	180
Minimum	410		440	510	410
Maximum	610		650	630	650
Males					
Average	554	240	580	576	570
Std. Error	7		5	17	4
Sample Size	55	1	129	12	197
Minimum	420	240	80	430	80
Maximum	650	240	650	650	650
Both Sexes					
Average	555	240	575	579	568
Std. Error	4		3	12	3
Sample Size	114	1	243	19	377
Minimum	410	240	80	430	80
Maximum	650	240	650	650	650

Appendix Table 33. Length-at-age statistics of coho salmon sampled at the Lake Creek creel site on the Susitna River during 1988.

	Age Class						
Sex	1.1	2.0	2.1	3.0	3.1	4.0	TOTAL
Females							
Average	561		567		573		566
Std. Error	4		2		9		2
Sample Size	51		162		10		223
Minimum	490		475		525		475
Maximum	620		630		615		630
Males							
Average	560	290	577	344	606	354	568
Std. Error	7		3	4	6	14	4
Sample Size	44	1	165	4	21	4	239
Minimum	425	290	435	335	560	330	290
Maximum	620	290	640	355	645	390	645
Both Sexes							
Average	560	290	572	344	595	354	567
Std. Error	4		2	4	6	14	2
Sample Size	95	1	327	4	31	4	462
Minimum	425	290	435	335	525	330	290
Maximum	620	290	640	355	645	390	645

Appendix Table 34. Length-at-age statistics of coho salmon sampled at the Alexander Creek creel site on the Susitna River during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	552	538	610	548
Std. Error	10	11		10
Sample Size	3	7	1	11
Minimum	535	495	610	495
Maximum	570	580	610	610
Males				
Average	505	550		540
Std. Error	28	15		14
Sample Size	3	10		13
Minimum	470	445		445
Maximum	560	600		600
Both Sexes				
Average	528	545	610	544
Std. Error	17	10		9
Sample Size	6	17	1	24
Minimum	470	445	610	445
Maximum	570	600	610	610

Appendix Table 35. Length-at-age statistics of coho salmon sampled at the Eklutna Hatchery during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	515	534		517
Std. Error	8	21		8
Sample Size	49	5		54
Minimum	395	460		395
Maximum	600	580		600
Males				
Average	498	483	525	498
Std. Error	5	17		5
Sample Size	120	7	1	128
Minimum	375	420	525	375
Maximum	615	560	525	615
Both Sexes				
Average	503	505	525	503
Std. Error	4	15		4
Sample Size	169	12	1	182
Minimum	375	420	525	375
Maximum	615	580	525	615

Appendix Table 36. Length-at-age statistics of coho salmon sampled in miscellaneous upper Cook Inlet west-side streams during 1988.

Sex	Age Class 1.1	2.1	3.1	TOTAL
Females				
Average	508	569	603	567
Std. Error	4	13	10	11
Sample Size	3	15	4	22
Minimum	500	490	580	490
Maximum	515	650	630	650
Males				
Average	538	582	583	575
Std. Error	37	11	8	10
Sample Size	5	27	2	34
Minimum	463	439	575	439
Maximum	655	670	590	670
Both Sexes				
Average	527	577	596	572
Std. Error	23	9	8	8
Sample Size	8	42	6	56
Minimum	463	439	575	439
Maximum	655	670	630	670